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6 December 1984 No 1433 Weekly 90p

CHRISTMAS BOOKS

newscientist

The risks you take with a pinch of salt

Johnnie Walker
BLACK LABEL
Old Scotch Whisky
40% vol
75 cl
YEARS 12 OLD
BOTTLED IN SCOTLAND
OTHER PLEASURES PALE BESIDE IT

AP

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Zoological Society of London

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Ingram Pinn

Put some butterflies in the stockings, Christmas Books, p 33

This week's cover is illustrated by Tim Moore

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The art of welding

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Ariadne

This One
DBGN-9JY-U19E

The overlords of science

IT TAKES A lot to bring middle-aged Conservative Members of Parliament out on to the streets alongside young university students. And yet that is just what the Secretary of State for Education and Science may have done with his attack on student grants. Sir Keith has provoked uproar in the shires with his plan to slash the university grants to the children of wealthy—or should that be, "not poor"—parents.

The first warning of trouble came in a debate in the House of Lords. Not long after Sir Keith Joseph revealed his plans to pick the pockets of the people who voted him and his boss into office, Lord Adrian warned that "already students at Cambridge, and I believe elsewhere, are today demonstrating about the new charges on their parents". Cambridge of all places! If they take to the streets there, then heaven help university towns.

Lord Adrian was speaking in one of those debates at which the peers of the realm excel. And why not? There is more scientific talent in the Upper House than there is in the Department of Education and Science, and even the department has no difficulty in surpassing the scientific talents of the "lower" house.

The issue of student grants arose in a debate on the research councils—actually a wide-ranging hike around research in Britain—which confirmed, once again, that discussion of scientific matters in the upper house is far superior to any "debate" on just about any topic in that animal farm along the corridors of power.

Noble lord after noble lord chipped in with personal experience of institutions on the brink of extinction. The peers were quick to grasp the fact that Sir Keith is trying to play Robin Hood with his bit of highway robbery. As Lord Adrian said: "If we are to see, as I fear we shall, more students forced into debt by the inability, or even the unwillingness of their parents to pay, it will not comfort us much at the university to think that their hardship is supporting the research councils. If this charge were, in turn, to discourage some from going to university to read science, the decline in our science base would be reinforced."

It is this bit of legerdemain that has upset many people. Sir Keith has niftily shifted £24 million from student grants to help to pay for research. Scientists are grateful that Sir Keith has finally acknowledged the plight of research, but they don't want their students to have to pay for the research. But who can blame Sir Keith? We have an unbending Chancellor of the Exchequer who seems determined to blow £3000 million, and the money he rakes in from selling off British Telecom, on tax cuts. It isn't as if there are pickets outside 11 Downing Street demanding tax cuts.

Thus there are two problems facing Britain's universities: they are short of funds for research; their students could be so short of funds that good ones eschew the academic life in favour of a career with a less burdensome entry fee.

There is no denying that students and their families could pay for further education with the aid of loans. But it is wrong to introduce fundamental changes through the back door. In countries were loans are common practice, parents can begin to save for the education of their children before they even conceive them. Britain's parents have exactly a year in which to find what, for some, could be crippling amounts. And in other countries the educational institutions are good at producing funding packages for their students.

It may well be that the Committee of Vice Chancellors and Principals, say, is even now talking to the banks and building societies about a loan scheme—and it would serve the government right if some clever clogs of an accountant found a way to make the whole thing tax deductible—but that too would take more than a year to reach fruition.

The other side of the problem is the plight of the research community. Here too we see action taken too quickly and with too little thought. For a government that talks as if it expects to be in power until the day the Sun freezes over, Mrs Thatcher's regime shows remarkable haste in everything it does.

In the beginning of its attack on public expenditure, the DES robbed the equipment grants of the various councils to pay off redundant researchers. It also acquiesced in pay rises way above the increases in the budgets of the research councils and universities. As the Earl of Cranbrook put it in the debate: "After cash limits have been set, pay awards are permitted by the government outside the control of research councils that make a nonsense of the cash limits." The government didn't think that through and is now hastily attacking students' grants in an attempt to find money to recover some of the lost ground.

In his reply to the debate, the government's spokesman, the Earl of Swinton did have the grace to admit that "there is some evidence that the reductions in the grants allocated to the universities have fallen disproportionately on research". He didn't, though, hold out much hope of any improvement, unless, that is, you are a researcher in the defence business.

The government, he said, is "committed to maintaining expenditure on defence, including research and development related to defence needs". Apart from the fact that the country shows little sign of clamouring for more defence R&D, does the government believe that it can pluck this military research out of nowhere? It will take trained scientists to do the research. And there has to be a "pure" foundation on which the defence establishment can build its "impure" work. Even the Earl of Swinton admitted that "an insignificant part" of budget for defence R&D is devoted to pure research.

As usual, the government shows remarkably little understanding of how research works. Its ministers, especially the Chancellor of the Exchequer, would do well to read the debate in the House of Lords. They will learn a lot. And they will learn some of it from people who are on their side of the political divide. □

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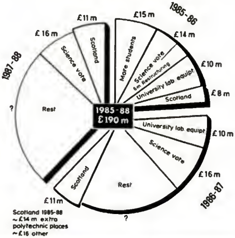
THIS WEEK

Parents pay for jobs lost in science

Steve Connor



EDUCATION IS A RIGHT AND SHOULD BE FREE
LEEDS SAYS NO TO NO GRANT
IS A RIGHT
EDUCATION IS A RIGHT AND SHOULD BE FREE
STOP THE CUTS

Simon Grosset

Where Joseph's savings will go

PARENTS of British students will help pay the cost of putting scientists out of work. Part of the money that Sir Keith Joseph, the Secretary of State for Education and Science, wants parents to pay for their sons' and daughters' education will go directly into the pockets of scientists made redundant or forced into early retirement because of the "restructuring" of the research councils.

As a result of Joseph's plan, £14 million will be added to the science budget for the next financial year. £6 million of this is set aside for restructuring of the research councils. This money will have to be spent on putting scientists out of work. Their jobs could be lost forever.

The £14 million saved by increasing the contribution made by parents to student grants is part of a much larger package of savings. In the next financial year the total amount expected to be saved by government in England and Wales comes to £40 million, and £60 million in the following two financial years. In Scotland the savings will run to £8 million in the first year, and £11 million in each of the subsequent two years. This brings the total expected saving in Britian over three years to £190 million.

Joseph has justified charging more for student education on the grounds that science desperately needs the money. "The desperate plight of the scientist," he said last week, "could wait no longer."

Of the £40 million that will be raised next year, £14 million will go to the research councils to "support projects of high scientific promise", says the Department of Education and Science. It will also help meet the cost of cutting jobs.

The Agricultural and Food Research Council estimates that it will need about £6 million next year and another £6 million the year after to help its plans for restructuring. The Natural Environmental Research Council said last week that it will need about £2 million for its restructuring.

Joseph plans to give £10 million to help re-equip university laboratories next year and another £10 the year after. The rest of next year's £40 million will go towards paying for the greater number of students who are expected to want university places.

In Scotland, £14 million raised from the pockets of parents will go towards increasing the number of places at the Scottish polytechnics from 500 to 800. The government has not yet decided how to spend the rest of Scotland's £30 million saved over the next three years.

There is a similar question mark hanging over the destination of the money that will be saved over the next three years in England and Wales. However, the recommendations of the Advisory Board for the Research Councils, published this week, are that the science budget should have an extra £16 million each year on top of any other increase.

The chairman of the board, Sir David Phillips said that Joseph's plans would enable the research councils to fund an extra 600 alpha-rated research projects. It would help new research in food, plant and animal sciences, it would provide money for medical research and it would help develop computing for applications in engineering and information technology.

Joseph's plans have, however, come under fire from the Committee of Vice-Chancellors and Principals. The secretary general, Brian Taylor, has this week written to MPs complaining of the government's "absence of consultation" in making a decision to increase parental contributions towards student grants. "The consequences of which are many and serious."

Taylor adds: "An increase in support for scientific research and equipment is desperately needed."

The president of the Royal Society, Sir Andrew Huxley, has also condemned Joseph's package. He said last week that students must find it galling to be less independent and less supported. □

OBSERVER David Austin
IT'S ROBBING PETER TO PAY PAUL TO SACK SIMON...
DES
EXTRA CASH FOR SCIENCE FROM STUDENT GRANTS
PLANS TO RESTRUCTURE RESEARCH
SERC.

Environmental studies under threat

RESEARCHERS in some areas of environmental sciences may find that Britain has decided to axe their subjects completely from further financial support. The details will emerge early next year with the publication of the corporate plan for the Natural Environment Research Council (NERC), which is responsible for research in the Earth and atmospherical sciences, and in terrestrial and aquatic life sciences.

The council is suffering so badly from government stringencies that it is thinking of dropping whole areas of activity that it currently supports. Last week the NERC's new chairman, Hugh Fish, presented the council's annual report, and a pessimistic view of future environmental research. "Possibly we shall have to drop some areas of science in which we are involved. One hopes these will be only temporary measures, but some may have to be permanent," he said.

In 1983/84, the council's income from commissioned research and from government came to £89·8 million compared with £87·8 million the previous financial year. The income from commissioned research continued to drop, this time by 9·3 per cent, and totalled only £26·7 million. Because of these cuts, said Fish, "we have not been able to provide our scientists with the support and equipment to enable them to do the best job they can."

Fish would not elaborate on the plans for restructuring except to say that "we do not favour closures of complete institutes or compulsory redundancies". Jobs at all grades have fallen by 3·5 per cent a year in the past three years.

The Council hopes to sell more fruits of its research at home and overseas. The council has set up offices and representatives in Brussels and Washington, and has a marketing budget of about £100 000. "The hope is that this part of NERC will be self-supporting," said Fish.

NERC's support for research at universities and polytechnics increased by 9·7 per cent in 1983/84 on that for the previous year. However, the number of new grants plummeted by 35 per cent to 116, and their value dropped 19 per cent to £3·2 million. Fish wants to increase the NERC's support of university research. □

New deal harpoons Whaling Commission

Jeremy Cherfas

AN AGREEMENT between the United States and Japan over Japan's continued whaling appears to rob the International Whaling Commission (IWC) of any role in the regulation of the hunt. Japan has agreed to withdraw its objections to previous decisions of the IWC, in exchange for which the US will not invoke commercial sanctions.

The IWC has never had any power over nations, whether members of the commission or not. Decisions are not binding on any country that objects formally to them and there are no sanctions to prevent objection.

The United States, with two pieces of legislation at its disposal that can drastically restrict fisheries trade with other countries, has always been the power behind the IWC. But the new agreement with Japan brings this out into the open. The agreement refers to "catch limits acceptable to the government of the United States", with no mention of the IWC. Dr Ray Gambell, secretary of the IWC, commented that "you don't need an IWC any more, you just need the US".

Legislation requires the United States' commerce department to "certify" any nation that "diminishes the effectiveness" of the IWC. Certification should then be immediately followed by halving the quota of fish that may be taken from the US's 200-mile zone. Japan takes fish worth $750 million a year from US waters, while the Japanese whaling industry is worth about $40 million a year.

C. Plowden/Greenpeace

One of two sperm whales landed in Japan on 11 November

Pat Heron/Greenpeace

The US will allow Japan to take 400 sperm whales this season and next, even though the IWC agreed that none should be taken. Furthermore, if Japan withdraws its objection to the sperm whaling ban before 13 December, the US will allow a further 200 in each of the following two seasons. But then the whaling must stop.

A second issue is Japan's objection to the moratorium on commercial whaling, which is due to come into force next year. Once again, the US has said that if Japan withdraws its objection to the moratorium, then the US will allow two more seasons of commercial whaling without certifying Japan.

The quotas allowed Japan by the US are in line with those recommended by the scientific committee of the IWC in previous years. But the agreement between Japan and the US makes no allowances for other whaling nations, most notably the USSR.

The most important remaining commercial catch is of minke whales in the southern hemisphere. Japan and the Soviet Union have traditionally shared the quota equally. This year, however, the USSR objected to the IWC quota, saying that it intended to take the same number as last year, about 3300 rather than about 2100. Japan has not yet objected to the quota, although it has until 6 January 1985 to do so. But the US's commerce secretary, Malcolm Baldridge, stressed that the current agreement "does not insulate from certification" any take of minkes beyond the current quota. Japan and the USSR have not yet had their customary talks about dividing the quota.

The agreement between the US and Japan, although it permits at least two more years of whaling, should ensure that Japan stops by 1988. The US, however, still faces a problem at the 1985 meeting of the IWC. All the moratorium decisions will have been taken. So almost the only substantive item will be the catch of bowhead whales by Alaskan Eskimos. The scientific committee of the IWC has long been agreed that this is the most threatened of whale species, but the US has continued to obtain a quota for the Eskimos. In 1985 the US will again require a bowhead quota to be set. ☐

Germans pull out of sea-law treaty

THE WEST German government announced last week that it will not sign the UN's Law of the Sea treaty by the deadline of 9 December. Observers at the UN fear the decision will severely weaken the treaty and deepen the split between the Third World and rich Western nations.

The German government said that it believes the treaty is in most ways a good development in international law. But it cannot sign because of "serious reservations" about the treaty's proposals for mining the seabed.

The decision followed a split in the West German cabinet in which business and economics ministries overruled foreign minister Hans Dietrich Genscher, who favours signing.

The Law of the Sea was adopted by a UN conference in Jamaica in 1982. It is supposed to apportion the resources of the world's seas fairly among countries. Nations have until 9 December to sign it, after which their governments may begin ratification proceedings. The treaty will not come into force until 60 nations formally ratify it.

But many western nations have objected to the treaty's attempts to ensure that nations with the wealth and technology to mine the seabed share the proceeds and know-how with poor countries.

The US opposes the treaty because of its own plans for mining. Shortly after the US elections, President Reagan wrote to West German Chancellor Kohl to renew his request that Germany reject the treaty.

The treaty's supporters, especially the Group of 77 Third World nations, are afraid that without backing from rich countries, there will be no money to enforce the treaty. The last meeting of the Law of the Sea Commission, in Geneva in August, revolved around attempts to persuade European nations to sign (*New Scientist*, 30 August, p 3).

Britain, like the US, says the mining provisions' interfere with free trade. Of the other European nations with interests in mining the seabed, France and Holland have signed. Belgium and Italy will probably follow West Germany's decision.

In August, the West Germans said they would sign if privileged status were granted to their AMR company. Its rights to mine under the Law of the Sea are jeopardised because it participates in an American consortium. Since President Reagan's reelection it is virtually certain that the US will ignore the Law of the Sea. But the assembly in Geneva said that it would consider Germany's request only if Germany signed.

Ratification will be the treaty's next big test. France and Japan, who have both signed, made it clear in 1982 that they would ratify only if provisions demanding the transfer of mining technology and definitions of company ownership were adjusted. Also, Dutch experts feel it is better to work within the convention than outside it.

West Germany also announced that, although it will not sign itself, it would not veto the EEC from doing so. The Treaty of Rome requires any new undertaking by the community to be approved by all members. Five EEC states have signed, and Germany and Italy say they will not obstruct signing. Belgium and Luxembourg are unlikely to block the EEC.

This means that only Britain, which has been consistent in its rejection of the treaty, may block the EEC's signing. ☐

Seventeen years' research up in flames

THE TWO main organisers of last weekend's controlled plane crash are telling different stories about why the experiment ended in a fireball.

The test was supposed to demonstrate that a fuel additive invented by ICI would greatly reduce the risk of an airliner catching fire after a crash. But to the embarrassment of ICI and NASA, which staged the crash, the remotely controlled Boeing 720 burst into flames shortly after ploughing into a runway at Edwards Air Force Base, California.

ICI's team on the spot said this week that the impact was more severe than it intended. NASA said the crash went according to plan. A full report on what happened will not appear for two months.

FAA/NASA

Who are the dummies now? The Boeing's plastic passengers were expected to survive. But all "died" in the fireball

The crash was the climax to 17 years' work on a substance called anti-misting kerosene. It is a remarkable product of ICI's skill with polymer engineering. The idea is to mix aviation fuel with a special polymer, which prevents a mist forming when the tank is ruptured. If no mist forms, the fuel will not burn.

Scientists at ICI's Paints Division in Slough, working with Britain's Royal Aircraft Establishment, have developed such a substance which ICI calls Avgard. The plan is that ground crews will blend Avgard with a carrier fluid which can be pumped into an airliner's tanks when the plane is refuelled. The mixture alters the fuel's rheological properties so that it does not form fine droplets.

One of ICI's team says that modified fuel behaves like "a forkful of spaghetti". Because it suppresses the formation of mist, not vapour, Avgard works only with kerosene (jet fuel) not with petrol.

The snag is that no modifier must be in the fuel when it reaches the combustion chamber. The Federal Aviation Administration has developed a restorer in the fuel system which changes fuel back to its virgin state before it is burnt.

The problem of modifying the fuel systems of airliners, together with the cost of converting simultaneously all the world's airliners, worries some authorities (*New Scientist*, 5 April 1984, p 4). But until now, the additive itself has worked perfectly.

In tests with a Second World War plane that was "crashed" on a rocket-powered sled, the modified fuel did not catch fire. An identical plane, with conventional kerosene in its tanks, became an inferno when crashed on the same rig. "These and numerous other tests have confirmed the ability of Avgard to suppress post-crash fuel fires in impact-survivable crashes," ICI said this week.

Hence the surprise that last Saturday's crash—painstakingly prepared, and carefully staged in front of civil aviation officials from the US and Britain—turned out the way it did.

ICI says the Boeing 720, flown remotely by one of NASA's veteran test pilots, came down at a steeper angle than the 6° specified for the test. When the plane hit, the wings did not shear away as expected, but stayed with the fuselage.

Some observers believed that as the plane hit the ground, a wing snapped off and penetrated the cockpit. The wreckage caught fire immediately, and burnt over a limited area for 10 seconds. A few seconds later, the whole plane erupted. "The fire came as a complete surprise," ICI said.

David Lane of ICI, who watched the crash, said: "We had maintained all along there would be flames from the engines as they burnt spilling fuel, and small fireballs behind the crashing aircraft. But it should have slid away from these. This appears not to have happened."

But a representative of NASA said on Monday that the impact went as planned, though "it was slightly to the right of target". He said that the glide slope of the descent was 3-4°—almost exactly that predicted.

Of ICI's statement that the crash was not "impact-survivable", the representative said "I don't know how they know that. When the data comes in we're going to look at it."

Michael Cross

Fleet Street dirt

FLEET STREET's printing presses are turning parts of central London into a serious pollution hazard. Concentrations of lead in the dust in streets around Britain's national press sometimes exceed 20 times the "action level" set by the Greater London Council's scientists.

The lead comes from the metal used in the street's presses, according to the council, which conducted the survey. The dirtiest streets, with up to 122 000 parts per million (ppm) of lead in the dust, were around *The Times*. Next worst was the *Mirror* with 79 000 ppm, followed by the *Sun* at 39 000. ☐

Huxley attacks minister

A SUGGESTION put forward by a British science minister for a European science academy was condemned last week by Sir Andrew Huxley, the President of the Royal Society. Such an academy, if funded directly by government departments, would be run by politicians and not scientists, he said.

The idea of "the Leonardo Academy" was put forward in September by Peter Brooke, an under-secretary at the Department of Education and Science, at a meeting of the Council of Europe. It would be a way of promoting scientific cooperation in Western Europe, he said. But Huxley believes that this "would be trifling in comparison with the injury that would be inflicted by a body-blow such as Britain's withdrawal from CERN (Europe's high-energy physics laboratory).

Britain's expensive involvement in CERN is currently under review by a group led by Sir John Kendrew. It is expected to publish a report early next year on whether Britain should pull out of CERN.

Huxley has told Kendrew's group that Britain would lose its credibility with its European partners if it withdrew. He said that this "would set a dangerous precedent for other countries by implying that international science would receive lower priority than national science at times of economic pressure." ☐

London plant paradise

A WILD plant paradise has been discovered in deepest surburbia—in east Hillingdon, West London. Amongst the botanical finds are wild orchids, the adder's tongue fern (*Ophioglossum vulgatum*), sneezewort (*Achillea ptarmica*), and the biggest surprise of all: the narrow leaved dropwort (*Oenanthe silaifolia*). The site is a rich undisturbed meadow on the banks of a river, where all these plant species, and the dropwort in particular, thrive. The discovery was made by Tony Hare, working for the London Wildlife Trust, as part of a scheme sponsored by the Greater London Council to survey wildlife sites in every London borough. ☐

France packs AIDS kit

FRANCE is to begin clinical trials of a diagnostic package to combat AIDS. Institut Pasteur Production, the production and marketing arm of the Paris-based research centre, is to distribute 20 000 tests to 10 hospitals and blood transfusion centres in France from January. The aim is to detect blood samples which contain antibodies to the virus thought to cause AIDS, and thus eliminate the spread of the disease via transfusion.

If trials prove successful, the institute hopes the tests will be on the market throughout Europe by next summer. American companies, such as Abbott and Ortho, are also in the running to reach the marketplace. The institute believes that in 1985 alone there is a potential market of 80 million of the $2 tests.

The name of the test is ELISA standing for enzyme linked immuno-sorbent assay. These identify virus antibodies manufactured by the body in response to the virus. The French test is designed to detect the lymphadenopathy associated virus (LAVI) discovered by the French early last year. ☐

Ministers reject clean-up of acid rain

Catherine Caufield and Fred Pearce

THE BRITISH government this week snubbed two parliamentary select committees, the Royal Commission on Environmental Pollution, and its own environment department in rejecting their calls for action on acid rain.

A white paper rejects the recommendations of all four bodies. In September the House of Commons select committee on the environment called for Britain to cut its emissions of sulphur dioxide (SO_2) and nitrous oxides by 60 per cent by 2000, in accordance with an EEC draft directive. The previous month, the House of Lords select committee on the European Communities recommended the immediate fitting of flue-gas desulphurisation equipment on at least two power stations. Last February the Royal Commission called for a pilot scheme to cut SO_2 emissions from coal-fired power stations.

Greenpeace

The message fell on deaf ears in Cabinet

Environment ministers and expert advisors had lobbied privately for Britain to join the "30-per-cent club", of countries committed to reducing their emissions of SO_2 to 30 per cent of their 1980 levels by 1995. But they were over-ruled by the Treasury and the Department of Energy.

The white paper gives two reasons for the government's decision not to join the club. First, it is not necessary, because Britain's emissions have already declined by nearly 40 per cent since 1970. Secondly, "stronger growth in electricity demand could reverse these trends" and could necessitate the expenditure of several hundred million pounds if Britain was to meet the requirements of the club.

The government has decided to accept the calls of the Commons select committee and the Royal Commission for a more extensive network of air pollution monitoring stations. A network of about 20 nitrous oxide and 10 ozone monitors "is currently being considered".

The white paper rejects the Commons' select committees call for research on the health effects of air pollution. The Clean Air Act, it says, has eliminated the "clear-cut acute effects of air pollution on health", and other pollutants are not present in concentrations high enough to "suggest the likelihood of significant effects".

Ministers are certain to face an angry reaction to their decision when the commons debates acid rain next week. And they will have to defend their position again when the first summit of environment ministers meets in London the following week.

Behind the politics the scientific debate over acid rain is still in full flow. The claim from the British electricity industry that nitrous oxides from car exhausts are an important source of acid rain is now accepted by environmentalists.

Friends of the Earth this week said that 30 per cent of rain acidity in Britain now comes from nitrous oxides rather than SO_2. And it agreed that ozone (again caused by car exhausts) was a main cause of forest damage.

But the group stood firmly by another assertion: that any fall in acid emissions should cause a proportional reduction in acid deposition. ☐

Sizewell radiation fears quashed

FEARS that workers at Britain's first pressurised-water reactor (PWR) face double the radiation dose expected may be largely groundless. The issue was scrutinised at the marathon Sizewell B public inquiry this week.

The Central Electricity Generating Board says that no more than 240 man-rems should be inflicted on workers at Sizewell B in any one year. Opponents say the real figure may be double this.

The opponents' case was based on evidence supplied by French trade union researchers. It formed part of the case marshalled by the Anti-PWR Consortium, a group of British unions and local authorities fighting the Sizewell scheme.

The French material relied on data on collective doses experienced at PWRs around the world and particularly in France. According to the researchers, these figures showed that a more realistic radiation dose figure for Sizewell B would be between 400 and 460 man-rems a year.

The generating board countered this claim by showing that the French researchers had not compared like reactors with like. They had not taken account of the greater use of remote-handling technology that will cut down manual maintenance work at Sizewell B. And they had failed to realise that the generating board is specifying low-cobalt alloys for the primary circuit at Sizewell B.

High-cobalt alloys in most existing PWRs cause an accumulation of highly radioactive cobalt-60 during reactor operation. This is the largest single contribution to the collective dose for PWRs.

When the inquiry opened, the government's safety body, the Nuclear Installations Inspectorate, doubted whether the board could meet its target doses. But this week it told *New Scientist* that it is now largely satisfied. ☐

Sex and the resistant apple moth, hanging out in New Zealand

SEX PHEROMONES are being used by scientists in their battle against insects' growing resistance to pesticides. Experiments now under way hope to show that pheromones can be used to breed pests with a lower resistance to insecticides, a symposium in Washington DC heard last week.

Insects survive pesticides by developing a genetic trait which detoxifies the chemicals. This trait is passed on to successive generations. To overcome the problem population geneticists are devising ways of lowering the frequency of resistance genes in the pest population.

Scientists in New Zealand are deploying the sex pheromones in experiments with apple-moths. A synthetic sex pheromone (pheromones are chemicals secreted by animals and insects to affect the behaviour of their fellows) is hung on trees to confuse male moths so they miss the females. The next step is for a small plot to be sprayed with an insecticide, which will kill all but a few resistant moths. The sex pheromone will then be used to lure untouched males into the plot. When the pheromone is removed, the hordes of newcomers will have a better chance of mating with pesticide resistant females, flooding the colony's gene-pool with susceptible non-resistance genes. This trait will then be passed on to the next generation. Other scientists are trying to breed insects whose gene for resistance is recessive rather than dominant.

But, the symposium, sponsored by the National Academy of Sciences, was told, these tactics required identifying the resistance genes, and this was difficult. Further it could be done only with hindsight, after a pesticide had been developed, at a cost currently reckoned to be in the region of $20 million.

But the need for some breakthrough was urgent, said Professor George Georghiou, an entomologist at the University of California, Riverside, as the growth of resistance among insects is accelerating every year, and now totals 447 species resistant to at least one class of pesticide. It is also spreading among crop parasites and rodents, and the cost of agricultural resistance already amounts to billions of dollars.

Entomologist Professor Brian Croft of the University of Oregon and Michael Dover of the World Resources Institute have shaken the industry by suggesting it should assess the risk of resistance for each new pesticide before approving its use. ☐

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Secrets of the artificial heart business

Ian Anderson, San Francisco

A STAUNCH critic of America's $200-million drive to develop an artificial heart, has been denied more than 100 pages of "sensitive" material related to the early history of the programme. Barton Bernstein, professor of history at Stanford University, says that two agencies—the National Institutes of Health (NIH) and the National Heart, Lung and Blood Institute—are "wilfully stretching the rules in order to insulate this programme from public knowledge". He also warns that private companies are about to take control of the business.

AP

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This heart has a registered trade mark. Dr Robert Jarvik (left) invented the Jarvik-7. Here he primes it before putting it into the chest of William Schrober during a $250 000 operation last week

Bernstein, who is working on two books on the development of the artificial heart, applied for the documents under the Freedom of Information Act. He accuses the agencies of wanting to bury past mistakes and to rewrite the history of the artificial heart.

The documents cover the period 1964-1977. Bernstein says they involve scientific arguments for and against the artificial heart. He initially applied to Washington for the documents last May. But a series of promises to supply copies of various documents were broken. This week the NIH said the release of the 109 pages of documents was "still under review".

At Stanford, Bernstein is part of an interdisciplinary group, called Ethics and Values in Science and Technology, that is examining biomedical innovations and public policy.

By coincidence, Bernstein's latest broadside appeared in the same week that America's second implant of an artificial heart was performed in Louisville, Kentucky.

Writing in *Technology Review*, Bernstein said that since its beginning in the mid-1960s, "medical experts—heart surgeons and bioengineers—and their allies in federal health agencies have shaped the issues surrounding the developments of the artificial heart, defined the agenda, determined how to evaluate progress, implemented the programme, and spent the money."

The cost per patient could be $250 000, more than 10 times the initial forecast, Bernstein claims. "Legislators will soon have to face the issue they have avoided—whether to pay for artificial hearts or allow only the wealthy to have them." He predicts that business firms will dominate the artificial heart business.

Last week the editor of the *New England Journal of Medicine*, Arnold S. Relman, said that Humana Heart Institute of Louisville, which conducted last week's implant and has approval for 100 more, has an excessive interest in publicity. "It's just like a commercial organisation promoting the release of a new product," he said.

Because Humana lacks teaching and research facilities, it is not the best place to carry out the procedure, Relman said. But a spokesman for Humana, a profit-making company, said that the institute's doctors did perform clinical research which was published in scientific journals.

Humana Inc owns or operates 91 hospitals. Last year the company had revenues of $2·6 billion and a profit of $200 million. Critics say that Humana, which stands to gain financially from the artificial heart, should not have control over such an experimental and dangerous procedure.

Bernstein warns that "prestige and profit" could ultimately weigh more heavily than patient welfare. He criticises William DeVries, the surgeon who moved to Humana from the University of Utah, where the first implant involving Barney Clark took place in late 1982. He said the move by DeVries "is a dramatic reminder that biomedicine is big business, that the artificial heart business is attractive to venture capitalists, and that researchers who earlier benefited from federal funding can build upon that work, keep many of their discoveries secret, and even slide away from federal oversight". ☐

Drink? I almost drove

DRINKING and driving is not a particularly serious offence, according to the drunkard in the bar. In the first survey of its kind the Transport and Road Research Laboratory asked 500 male motorists about their attitudes to drinking and driving, and about their drinking habits.

The result is a thumbnail sketch of the macho male; a strong right arm and a bloated beer belly. Only 9 per cent of the sample was teetotal. Another 9 per cent drank more than 19 pints a week, and the maximum admitted weekly consumption was a staggering 80 pints.

The survey was based on a door-to-door sample of male motorists; the sampling was timed so that it was not biased towards opening hours. The typical drinker (median of the sample) drank away from home on 2·4 occasions during the week, and consumed just over three pints of beer in a two-hour period.

The researchers divided the sample into high-risk and low-risk drinkers, and then asked them about their attitudes to drinking and driving. The high-risk group, 22 per cent of the sample, admitted to driving after drinking at least two pints of beer (20 grams of alcohol) an hour. This group also had a far higher annual mileage than the low-risk group. Some 32 per cent of the high-risk group drive more than 36 000 kilometres a year. The high-risk group was particularly prone to lunch-time drinking.

Despite the likelihood that a fair proportion of this mileage is undertaken when the driver is under the influence of alcohol, 86 per cent of the group have never been convicted of drinking and driving. ☐

French computer hackers enter nuclear files

Debora MacKenzie, Geneva

LAST WEEK, the French paper *Le Canard Enchainé* reported that it had obtained secret computerised information about the French nuclear programme. It did it through one of the hundreds of thousands of Minitel computer terminals handed out to customers by the French telephone company.

At the centre of the leak is a computer company, the International Company for Information Services (CISI), which is largely owned by the French Atomic Energy Commission. The commission uses about a third of its computer capacity, the rest being taken up by other companies, including major French defence contractors.

The Minitel terminal has been given to 525 000 French phone subscribers. They used it to interrogate a central computerised telephone directory.

Le Canard persuaded its Minitel terminal to read CISI files, which detail tests by the department of nuclear security, model simulations of this year's nuclear bomb tests at Mururoa, a laser project classed as "secret", and the storage of nuclear fuel. The files, edited to remove the most sensitive information, were printed in last week's edition of *Le Canard*. "The whole system is as accessible as a public park", said the paper.

Le Canard insists that it could break into the computer with the access instructions provided to every customer of CISI. The paper says it "borrowed" an access code from another customer. Once inside this customer's file, the paper asked for the names of other customers using the machine at the same time. The customers, and their access codes, were then displayed on the Minitel screen.

Le Canard says it could then take on the identity of any of these customers via a routine procedure called "Profile Command". This is described on page 38 of IBM's instruction manual for the CISI computer's operating system. Among the files opened up by this system was CISI's own company file.

This detailed the company's finances, including the Atomic Energy Commission's efforts to keep CISI afloat after substantial losses last year. It also listed the access codes of numerous subscribers, including Air Industrie and Matra, which hold aerospace contracts with the French government, and Thomson, which makes Exocet missiles.

The paper says it could also have altered the files. Safety systems keep any information from being irretrievably lost. But, as the paper says, the recovery process is "long and expensive".

CISI insists that such an invasion of its files required an informed insider, such as *Le Canard*'s computer operator, who was recently dismissed from CISI. A month ago, says the paper, this operator deliberately "pirated" information at CISI to which he was not entitled to demonstrate the flaws in the system.

CISI says the fact that he was caught "is the proof that security is assured".

But *Le Canard* says this is rubbish. It quotes the operator's colleagues: "Everyone knows that certain systems at CISI are like Swiss cheese, and you can access them easily. Our colleague's offence was to say so out loud." ☐

Cyanide in tube fire

LONDON's Victoria line could be closed for at least the rest of the year following last week's fire at Oxford Circus tube station. The northbound platform is now a concrete and iron shell having been gutted by the fire. The fire raises a number of questions about safety on the tubes, including the danger to passengers from cyanide fumes.

The fire was spotted by a passenger at 10 pm on Friday 25th November. Smoke was coming from a passageway being used to store contractors' materials. A fire at nearby Holborn tube station earlier this year also started in a temporary contractors' store. The traction current was turned off at 10.53 and the passengers evacuated. But the fire was not put out until 1am.

The causes of the fire are the subject of an internal investigation by London Regional Transport.

The heat of the fire was such that it stripped the tiles off the walls and spread to roof panels. The roof panels are made of melamine resin. Melamine itself does not burn and only melts at 365° C, but it decomposes when heated. Reference books say it is "dangerous when heated to decomposition. It emits highly toxic fumes of cyanides." ☐

Bronze Age shipwreck to be excavated

National Geographic Society

A SHIPWRECK dating from 1400 BC has been uncovered by archaeologists off the southern coast of Turkey. The Bronze Age cargo ship is the oldest ever excavated. Copper, tin and glass ingots, amphoras, pottery, gold objects and an elephant's tusk have been salvaged by a team led by Dr George Bass. Bass directs the Institute of Nautical Archaeology at Texas A&M University.

A two-handled Mycenaean Greek pottery cup helped to date the wreck. Divers, working at depths of 50 metres, also found pottery from Cypriot and early Phoenician or Canaanite cultures. Four handled copper ingots, first spotted in 1982 by a Turkish sponge diver who described them as "biscuits with ears", also helped to date the find. The ingots, are remarkably similar to those depicted in an Egyptian tomb at Thebes dating from about 1350 BC.

Only part of the vessel's keel and planking have survived the three-and-a-half millenia, but they indicate a ship's length of about 20 metres. Twenty-five years ago, Bass discovered a similar Bronze Age wreck about 70 kilometres east of the new site dating to 1200 BC. ☐

Case for ozone goes to court

A LAWSUIT filed against the Environmental Protection Agency (EPA) may push the US to devise tougher domestic regulations to protect atmospheric ozone. The Natural Resources Defense Council filed the suit recently to force further reductions in the production of chlorofluorocarbons (CFCs) in the US.

The long-lived chemicals, as well as some trace gases, are believed to attack the Earth's ozone layer. This layer in the upper atmosphere protects the Earth from harmful ultraviolet radiation (*New Scientist*, 15 November, p 10). CFCs are used as propellants in "aerosol" spray cans, in refrigerators and in industrial products.

"It seems that the only way that the EPA can be forced to do anything is to be put under court order," says David Doniger, the defense council's lawyer. The suit is based on the EPA's own proposals to limit production of CFCs. The proposals were published in 1980 but never adopted.

The plaintiffs say that the EPA's scientists know that the depletion of ozone poses a threat to public health. Thus, they argue, the EPA is obliged to set and enforce standards and regulations for emissions of CFCs. The government banned CFCs in "aerosol" spray cans in 1978. ☐

Thousand die in Indian poisoning

Debora MacKenzie, Geneva

POISON gas leaking from a pesticide plant killed more than 1000 people in central India this week, and injured more than 20 000. It was the sort of mass disaster which may become increasingly frequent as cities in the Third World grow and surround factories. The disaster would not have happened if European safety regulations had been applied to the plant.

The gas leak was at a pesticide plant belonging to the Indian subsidiary of Union Carbide, an American chemical firm. The leak began around one o'clock in the morning in the town of Bhopal, capital of Madhya Pradesh state. The gas, methylisocyanate (MIC), is an intermediate in the manufacture of carbamate pesticides.

MIC is heavier than air, and lingered in the neighbourhood surrounding the factory, killing many people as they slept. The gas is poisonous in concentrations over 0·02 parts per million and causes irritation and bronchial spasms which can lead to suffocation. Many of the town's 700 000 inhabitants fled to a hill to escape the gas, which eventually covered an area of 40 square kilometres.

Local authorities detained five officials of the plant. A team of scientists from Union Carbide's head office in Danbury, Connecticut was sent to Bhopal to and try to find out what caused the accident.

In Danbury, a spokesman for the company, Harvey Cobert, said the leak was not due to an explosion, but to an abnormal build up of pressure in a tank used to store MIC. The tank has valves which rupture if gas pressure increases, allowing it to escape before the tank wall is damaged.

In this respect the accident is similar to the one in Seveso, Italy, in 1976. There, increased pressure in a chemical reactor-vessel ruptured similar valves and released dioxin outside the factory.

Like the Seveso accident, the vents kept people inside the plant from being injured. Unlike the Seveso plant, however, the Bhopal factory vented the gas, not into the air, but into a secondary tank, equipped with a "vent scrubber". In the scrubber, a chemical reaction with sodium hydroxide (caustic soda) should have neutralised the poison.

Cobert said that the company does not know why the safety system failed to work. Reports from Bhopal say it was overloaded.

In response to the emergency, Union Carbide has taken what a company spokesman called the "extraordinary precaution" of closing its plant in West Virginia, which makes methylisocyanate. But Ian Cook, at the company's European headquarters in Geneva, says "other formulation plants and distribution channels are functioning normally". This includes the plant at Woodbine in the US which makes Sevin and Temek, the two pesticides manufactured at Bhopal. Another is the La Littoral plant at Bezier in France, which uses MIC to produce Temek.

In Bezier, MIC is kept in stainless steel drums each holding 213 kilograms. French law does not permit more than 280 of the drums to be stored in one place at a time. This means a total of 30 tonnes are stored at Bezier, but an accident can release only 213 kilograms at a time. The tank at Bhopal, which can release all the MIC if the rupture valves blow, had a capacity of 30 tonnes of MIC. The gas is stored as a liquid that vapourises and expands at 20°C.

The amount released is unknown. Company spokesmen in Bhopal say the leak was contained in 40 minutes.

One pesticide produced in Bhopal with MIC, Temek, is made only by Union Carbide. However, Union Carbide's pesticide Sevin, is also made by the Israeli firm Makhteshim. The pesticides, whose generic names are aldicarb and carbaryl, are classed repectively as "very hazardous" and "moderately hazardous" by the World Health Organisation. Neither Sevin nor Temek are made or used in Britain.

Dorothy Myers of the British aid organisation Oxfam says: "The Indian pesiticide disaster is only the latest example of the human suffering caused by the presence of extremely hazardous substances in the Third World." ☐

Milk lake to soak up a drought

AN EMERGENCY shipment of assistance to drought victims in Chad got under way last week, as the Red Cross began an airlift of 50 000 blankets and two tonnes of "protein pills". But although the pills, made from Europe's surplus milk, are handed out by the Red Cross throughout its Sahel relief operations, critics say they are unsuitable for starving children. The pills are a cheap way of draining Europe's huge milk "lake".

Relief workers from the French Red Cross say that starving children who have lost all interest in food will suck on the biscuit-like tablets and regain enough strength to begin eating again. The lightweight pills formed the main cargo in a televised French relief convoy across the Sahel in November (last issue, p 10). They seemed to be welcomed by hard-pressed relief workers, who gave them to children as emergency food.

Milk pills: better than nothing?

The French Red Cross has sent more than 80 tonnes of milk tablets to feed children in 25 disaster areas since 1982. But Oxfam, the Save the Children Fund and even the League of Red Cross Societies in Geneva all warn that the tablets could kill.

The danger is that hungry children will eat more than the recommended dose of one tablet a day. Each tablet contains only 100 calories, but as much as 18 per cent of this is in the form of protein. A baby being fed the tablets to provide enough calories to survive might die from eating too much protein, according to John Seaman of the Save the Children Fund.

The protein can cause a build-up of acid in the blood if it is not properly metabolised—for example, because the child is not eating enough carbohydrates or fats.

New dairy technology means that the tablets can be manufactured with a low lactose content, which should get round the widespread lactose intolerance in the Third World. But nutritionalists are sceptical about this benefit. Starving children may need an entirely lactose-free diet, they say. Any lactose at all may set up a reaction.

Unlike powdered milk, the tablets do not have to be reconstituted with water, which might be contaminated. But this, too, may be a problem. Starving children need liquids as much as solids. And the concentration of particles in the tablets could, according to some doctors, cause diarrhoea and contribute to dehydration.

The French Red Cross dismisses all this. It says the tablets were never intended to substitute for other foods. But while the French say that no more than one tablet should be taken each day by children, they also admit that distribution is "somewhat chaotic". Relief workers say that the tablets taste nice and children regard them as sweets. The tablets are in any case a very expensive diet supplement. A tonne of tablets, which would treat 1500 children for a month, costs around $3000, whereas a tonne of wheat, which also contains plenty of protein, costs around $155.

The fate of the tablets probably depends on whether the European dairy firms get their way and the tablets are added to the EEC's list of products approved for inclusion in EEC food aid programmes. If that does not happen, the French firm that maufactures them says it may make no more. They are not profitable enough. ☐

Fall and rise of the Caspian Sea

The Soviet Union has revived plans to divert Siberian rivers to irrigate its southern deserts, and save the shrinking Caspian and Aral Seas. Now it seems the Caspian Sea is not emptying after all

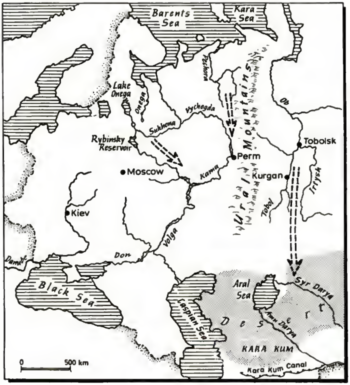
Fred Pearce

THE SOVIET Union can be coy about its environmental disasters. But it has always been open about one unfortunate consequence of its huge irrigation projects along the River Volga. They have cut the river's flow of water into the Caspian Sea by 25 per cent and, as a result, the sea is slowly emptying.

In 50 years the sea's surface area has shrunk by 10 per cent. When, a few years back, the water level appeared to rise again, scientists concluded that, rather than there being more water, the seabed was rising.

Now, according to reports from Moscow, a new analysis by the Azerbaijan Academy of Sciences has found that the sea bed is not rising, and that the Caspian is, after all, filling with water again.

This is most disorienting. Everybody has felt very guilty about the sad state of the Caspian—not least because its increased salinity has been damaging sturgeon catches, and hence the availability of caviar.



TASS

Canals are central to Soviet food production. New links (shown by arrows) could transform southern deserts

Two years ago, two senior Soviet academicians wrote in *New Scientist*: "Only the drastic measure . . . of diverting water from north-flowing rivers will now save the area." And last week, when the Supreme Soviet met in Moscow to discuss the next Five Year Plan, massive investment in diverting water from north-flowing rivers to the Caspian was high on the agenda. The aim was to boost further the water available for irrigation and to save the Caspian Sea.

But the finding that, despite the huge amounts of water being taken out of the Volga, the Caspian Sea is filling throws all this planning into doubt. Is Soviet Central Asia becoming wetter? If so might not nature water the grain and cotton crops without the need for the might of Soviet civil engineering?

Fluctuations of the water level on the Caspian Sea have a long history. There was a difference of seven metres between the first century BC and 1830, when regular records began. An intensive decline began in 1929 and saw almost a 3-metre fall in levels by the 1970s. Since then the level has risen again by about a metre.

This latest rise appears to have happened in spite of low rainfall which has created drought conditions in some of the Soviet Union's most productive farming areas in each of the last six years. A drought might be expected to reduce further the flow of water in the Volga.

According to Dr Abdul Kasymov at the Azerbaijan Academy of Sciences, however, the amount of rain falling into the lake (which covers an area the size of Great Britain) is rising sharply, while loss of water through evaporation is falling. Clearly something remarkable is happening to the Caspian basin.

The USSR's single most glaring recent economic failure has been the inability of its farmers to improve output in line with the current Five Year Plan. In the years 1980 to 1985 grain production was supposed to rise from 182 million tonnes to 240 million tonnes. In fact, this year's harvest is probably around 170 million tonnes. The USSR's biggest grain harvest weighed in at 229 million tonnes in 1979. Conspicuously, there was no announcement from the Supreme Soviet last week on this year's final tally. The result of this is that the USSR remains dependent on imports of grain, mainly from the US.

There are several possible explanations for the failures. Which one you choose seems to depend on your politics.

Two years ago, the arrival of Yuri Andropov as premier brought fresh air into the Kremlin, and with it claims that inefficiency was to blame for the laggardly agricultural performance. As late as March of this year, Mikhail Gorbachov, Andropov's protégé and the heir apparent to the current President, Konstantin Chernenko, repeated the charge.

Andropov's initiative of a new system of financial incentives for high production and more land for private tilling has survived his departure. But the crisis persists. Chernenko is seen as part of the old guard in the Kremlin, but he nevertheless chastised farmers for their inefficiency in his speech to the Communist Party's central committee at the end of October. "It is unforgivable," he said, "that projected crop yields are so far obtained in the country only from one-third of irrigated areas. The Rostov region, for instance, obtains from irrigated lands almost one-third less grain, fodder and other produce than the Crimean region. Yet the natural conditions in the steppe areas of the two are roughly equal."

Many observers believe that soil exhaustion and erosion may be to blame. Careless cultivation over the decades has reduced the humus content of even the best soils. And many badly designed irrigation systems have left waterlogged and saline soils.

But the apologists for the USSR's poor agricultural performance may also be right when they blame poor weather. This year Chernenko praised the "heroic struggle" of farmers to weather the "terrible drought hitting many districts" this year. He and his successors have been forced to say the same thing for the last six years.

The crisis has led the Kremlin to revive its gigantic proposals for bringing water for more irrigation from the north-flowing rivers to the south of its country. They hope to solve once and for all an underlying problem of Soviet agriculture. Water is plentiful in the north, while sun is plentiful in the south. If only the water could be brought to the sun, all would, be well.

Soviet scientists have, in the past 15 years, proposed a number of schemes to bring the waters south. The more fanciful ideas, such as persuading the Irtysh River to run backwards and building a vast reservoir rather larger than Hampshire to regulate waters flowing south, have been abandoned. They are now left with two schemes, one east of the Urals and one west. As outlined in recent months, they are as follows:

- To take water from the rivers Onega, Sukhona and Pechora in northern Russia to augment the Volga. This would ultimately involve 20 cubic kilometres of water every year, beginning with 6 cubic kilometres from the Onega and upper Sukhona, which could be irrigating a million hectares of land in the Northern Caucasus by 1990. This is a smaller version of an original plan to divert some 85 cubic kilometres of water to replenish the Azov Sea (a lagoon attached to the Black Sea) as well as the Caspian Sea basin. The scheme would largely rely on existing canals west of the Urals to transfer the water.
- To collect water at the confluence of the two large Siberian rivers, the Ob and the Irtysh and channel it via a new 2200-kilometre canal to the desert east of the Aral Sea. This is a vast scheme. But it will only take 6 per cent of the flow of the two rivers, and is much smaller than the plan as originally envisaged. Soviet scientists hope that their new plan will end fears that reducing flows of water into the Arctic could disrupt world climatic systems.

Camera Press

These schemes are central to Chernenko's aim "in a comparatively short time" to "extend the area of irrigated and drained lands [in the USSR] by 50 per cent". This, he hopes, will allow the country "to produce nearly one-half of its gross crop harvest irrespective of weather fluctuations".

In tandem with these huge new irrigation projects, ministers hope to develop new strains of crops, better fertilisers and pesticides, and to provide more farm machinery, such as tractors. The country's tractor fleet is planned to double in size to 7 million vehicles during the 1980s. That other Soviet resource, "cadres" of Young Communists, will also be brought to bear.

Soviet agriculture has a lot of catching up to do. Throughout Stalin's day it had a low priority for investment. The peasants on their newly collectivised farms were expected to generate surplus resources to build up Soviet heavy industry.

But after 1965 the emphasis changed. Nikolai Tikhonov, chairman of the USSR's council of ministers, reported to the central committee this October: "Since then the fixed assets of socialised agriculture have grown 4½ times over and now amount to about 300 000 million roubles." (Currently a rouble is worth about £1.)

More than 100 000 million roubles has been channelled into capital investment in those 20 years, including building reservoirs with an annual volume of 12 cubic kilometres. The areas of irrigated and drained land have grown from 17 to 33 million hectares. "World practice had not yet known such a scope and rate of construction," said Tikhonov.

Tikhonov pointed to substantial gains in production on these newly irrigated lands. But overall agricultural production, especially of grain, has been a severe disappointment. The aim now, according to Tikhonov, is to redouble efforts and to increase the area of improved land to 50 million hectares by 2000, of which 30 million hectares would be irrigated.

Camera Press

Tearing into the virgin lands. But what fate for the Caspian Sea?

This means more grain from the Volga region and, it is hoped, from virgin land in Siberia and the Far East.

Part of the current Soviet mood for reform is designed to satisfy the demands of its people for consumer goods of all sorts. The undoubted economic progress of the country (gross domestic product has grown by a further 2·5 per cent in the past year) has left money in people's pockets. But they have little to spend it on, because industry is still overwhelmingly geared to the production of iron, steel and tanks.

But, Chernenko informed the central committee, things are improving, especially in the formerly deprived rural areas. "Out of every 100 families in the countryside today 85 have TV sets, 87 have radio sets, 73 have refrigerators and some 60 have washing machines. Almost every second rural family has either a car or a motorcycle."

The highest priority for consumers today is meat and dairy products. To satisfy that demand Chernenko wants more cattle, and that means growing more fodder crops. Last year "improved lands" produced 37 million tonnes of fodder. Tikhonov wants to push this to 80 million tonnes by 1990 and 115-125 million tonnes by 2000.

The next priority is clothes. To make more clothes the Soviet Union needs more cotton. Since 1965, output of grain on improved land has trebled, output of fodder has increased six times, but production of cotton has shown a much more modest rise of around 50 per cent to 9 million tonnes a year today.

Some of the USSR's most dramatic and far-reaching irrigation plans in the south of the country are designed to produce a massive increase in cotton production. Tikhonov called for "further comprehensive development of large tracts of irrigated land in Central Asia, Kazakhstan and Azerbaijan".

The prime source of cotton in the USSR is the basin around the Aral Sea. But more than half the flow of the two rivers that feed the sea, the Syr Darya and the Amu Darya, is already taken to feed the fields. Whatever may be happening to the Caspian, the level of the Aral Sea is still falling steadily. It dropped by three metres in the past two decades and is in danger of drying up altogether by the end of the century.

The new canal from the Ob and Irtysh, which will be so large that ocean-going ships may use it, should bring an additional 4 million hectares of parched land under irrigation. The canal will connect the two Siberian rivers with the Amu Darya. This will, coincidentally, allow more water to be taken from that river into the Karakum canal which stretches for more than 1000 kilometres along the sensitive borders with Afghanistan and Iran in Turkmenia.

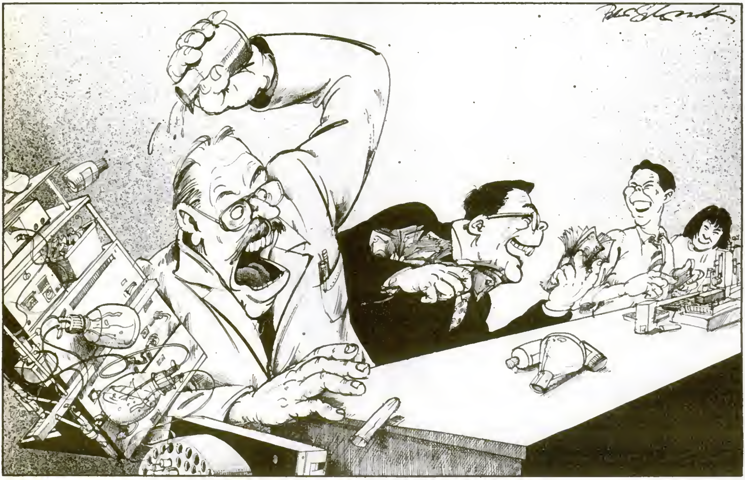
The plan is ambitious and fraught with dangers, not least to the desert itself. In an unusually outspoken article, published in *New Scientist* in 1978, the director of the Deserts Institute of the Turkmen Academy of Sciences wrote: "If the desert were to receive abundant water, everything that grows in it would die. For example, the saksaul tree would vanish. This is the basic fuel of the desert people."

Another casualty, he said, would be the plants on which the karakul sheep graze. More than half the republic is currently devoted to arid pastureland that suits these sheep. It would be ironic, and perhaps politically extremely costly in this Muslim land close to Iran, if a plan to grow more cotton for Russians were to destroy the habitat for the Turkmenian's wool production. □

Big is beautiful in biotechnology

Helpful bankers, large companies and some big ideas gave Japan the edge in silicon technology. Will Western venture capitalism, now prove to be biotechnology's weakness in the US and Europe?

Gene Gregory



Illustrations by Peter Schrank

IF ONE ingredient has guaranteed the successful launch of the biotechnology revolution since 1977, notably in the US, it is venture capitalism. Just as adventurous, behind-the-scene investors were largely responsible for the Golden Age of the entrepreneurial electronics engineer in the 1960s, they are responsible for new alliances in the late 1970s and early 1980s with biologists and immunologists. The gamble lies in the potential of industrial microbiology and, in particular, genetic engineering, to open seemingly limitless horizons for innovation and new industrial activity.

Since 1977, up to 200 new firms in the US have responded to opportunities to develop a wide range of new products: vaccines against everything from cancer to dental caries, diagnostics to detect heart disease or cystic fibrosis, new hormones that might produce cows as big as elephants, crops that grow in sea water, insects that eat toxic wastes or leach the last remnants of minerals from exhausted mines, and many more. Genetic engineering, fuelled with venture capital, has set in motion new industrial activities expected to account for $40 billion in worldwide sales by 2000, mostly of completely new products.

In no country has the reaction to American interest in biotechnology been more concerted than Japan. In particular, the successful manufacture of interferon and insulin by means of recombinant, DNA (rDNA) technology convinced Japanese companies of biotechnology's potential. Catalysed by the announcement of the Cohen-Boyer patent for the rDNA process in 1980, five leading Japanese chemical companies set up the Biotechnology Forum. Fearful that barriers to transferring technologies, such as patent restrictions, would shut them out of the race, many Japanese companies launched R&D programmes in genetic engineering and other fields of biotechnology.

In the early 1980s, Japanese companies discovered new potential in traditional bioprocessing technologies and found, via new applications of biotechnology, solutions to nagging problems of industrial structure aggravated by the energy crisis of the past decade. Biotechnological research rose by 20 per cent each year. More importantly, outlay for R&D in Japan more than doubled in four years while the number of researchers employed in biotechnology rose fourfold.

Although the need for rapid development, and to catch up with competitors in new fields of biotechnology, is recognised in Japan no new specialised entrepreneurial firms it has set up of the kind that have provided the dramatic thrust in the US. Instead, established companies in the commodity and fine chemicals, pharmaceuticals, food, beverages, textiles and paper industries are leading the rush into biotechnology.

In the US, two distinct sets of firms have developed, separating R&D from production and marketing. But biotechnology in Japan is being researched and made commercial within some 200 established firms that build on existing technology and past experience. The difference is crucial, but not for the reasons commonly given, and stressed in the report of the Office of Technology Assessment (OTA) to the US Congress, which appeared in January 1984.

Small entrepreneurial firms, founded in the US to develop new biotechnology, complement established companies, which put products on the market. This is generally acclaimed as one of the major reasons for the strength of America's bio industry—and it is a claim that is well justified. What is far from clear, however, is how well this structural arrangement will serve to sustain the development of biotechnology in future stages of its growth and diffusion.

It is significant that the cost of the OTA's report was justified on the grounds that Japan might well repeat its performance in microelectronics—following in the footsteps of the US at first, then streaking ahead when the risky commercialisation of the technology had been completed by venture-capital firms. The new competition from Japan would force American firms to accept acquisition by large American or European conglomerates.

Recent developments in the microelectronics, computer and communications industries have shown clearly that the early strength of specialised semiconductor companies in Silicon Valley has developed into a serious structural weakness. Japanese companies, on the other hand, are better organised to take advantage of the synergy derived from the convergence of rapid technological diffusion, economies of scale and learning curve management. These three macrotechnologies work best in the vertical management of families of interrelated companies.

More importantly, experience of the semiconductor industry demonstrates that, in the long run, not only is the specialised firm unable to sustain the pace of competition with a larger intergrated firm, but it eventually loses its main reason for existence. Unable to market its new products competitively, the specialised firm gradually loses its capacity for innovation. The fate of the specialised semiconductor manufacturers has been either replacement by new venture-capital firms, or acquisition by integrated electronics companies or conglomerates. In the process, the entire US semiconductor industry has lost competitiveness.

The venture-capital phenomenon in the development of American biotechnology may again prove to be an inherent weakness. Just when added propulsion is needed to complete take-off, this incipient revolution lacks competitive power.

Venture capital in the US developed in response to a major weakness in the financial system which mitigates against innovation in existing companies. The absence of efficient investment banking in the US, the abhorrence with which bankers regard investments in risky innovation, and the lack of other sources of finance suitable for a sustained effort at the forefront of new technologies, open the door to new entrepreneurial ventures. Enter the venture capitalists to fund new firms or "start-ups". They help successful innovators to "go public", then take their profits in the form of capital gains. They also leave the new firm to fend for itself in the financial system which was inadequate in the first place for established public companies to fund risky innovation.

Still no profit

The new biotechnology ventures in the US have developed precisely for this reason, just as the semiconductor industry was left open to innovative firms by electronic giants unable to finance the switch from valves to transistors. Unlike electronics, however, the payoff in biotechnology is less certain and at best takes longer—most of these new ventures have yet to turn a profit. For the final stages of commercialisation they have been largely dependent on established companies, at home and abroad, which they license to produce and distribute their latest inventions.

In Japan, on the other hand, established firms have been able to finance a remarkably rapid move into new fields of biotechnology. Despite the lack of movement of staff from the university laboratories to industry, these firms have shifted critical human resources expeditiously into this new field of R&D.

The experience of the Japanese microelectronics industry provides one clear and pertinent object lesson: the absence of start-ups does not necessarily mean less innovation. Entrepreneurship is not to be equated with venture business. Large Japanese companies in the basic materials, pharmaceuticals and textiles industries are at once highly motivated for innovation and are equipped with the necessary organisational, human and financial resources for diversification into biotechnology.

Entrepreneurship in the Japanese context is not reliant on venture capital as such. In the current proliferation of start-ups in robotics, it is apparent that funding is available even to small entrepreneurs capable of managing new technologies, just as it was in successive waves of new businesses in transistor radios, tape recorders, calculators and CB radios.

Venture capital of the American variety is, therefore, not in great demand in Japan, and would be, in fact, unacceptable on the terms it is usually offered. Moreover, the buying and selling of companies is looked upon in general with disfavour in Japan. Companies are essentially people, not assets; and people are not for sale.

Financial institutions and other major shareholders are generally expected to establish a long-term relationship with the firms they fund, whether with equity or loans. Japanese venture capital firms tend to assist only proven firms to go public, and to stay with them through future stages of growth. Japanese venture capitalists are, in fact, financing firms which will become long-term customers for their lending services.

There are more positive reasons for established integrated companies emerging as the leaders of the biotechnological revolution in Japan. Technologically, it makes good sense. Integration sustains innovation and assures rapid diffusion of its results.

Just as Japan's computer-makers provided the world's first effective response to IBM by strengthening and adding to experience gained in the manufacture of telecommunications equipment, the road to higher levels of biotechnology is shorter and the passage quicker if a company begins from related experience. Large, integrated companies also have the advantage of a continuing access to the money needed to sustain innovation.

Several hundred established companies in Japan have this kind of financial muscle and decades—even centuries—of experience in bioprocessing technology. Japanese industry is a world leader in, for example, enzyme technology, and the sole source of 21 of the 26 enzymes produced commercially at the end of the 1970s. Japanese firms are also predominant in markets for synthetic amino acids and account for more than 20 per cent of all new antibiotics introduced since 1980—exceeding the sum total of all those introduced in the US, Britain and West Germany in 1983.

The testing ground

Pharmaceutical markets are the likely testing ground for competitive strength in biotechnology. Japanese pharmaceutical companies are considerably smaller than the major international firms in the field and are, therefore, spending only a fraction of the amount devoted to R&D by their main competitors. However, the application of biotechnology to pharmaceuticals has made possible the entry of a wide variety of food, beverage, and even textile firms with extensive experience in production based on bioprocesses.

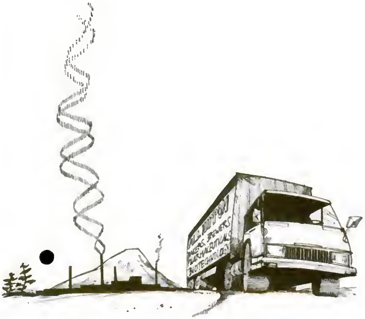
In 1982, according to a survey in the Japanese magazine *Keidanren* of 132 firms actively using biotechnology in production, at least 60 were engaged in applications to pharmaceuticals. Major brewers of beer and sake, distillers, shoyu makers and dairy-product firms have become leading developers and producers of bulk antibiotics. Synthetic fibre makers—such as Toray, Teijin and Asahi Chemical—have moved out in front in the production of interferon. And a large number of chemical, food processing, textile and pulp companies are producing anti-cancer drugs in bulk for packaging and distribution by leading pharmaceutical houses.

If this pattern of development is projected to other uses, the potential competitive position of Japanese industry is strong. Expenditure by Japanese firms on pharmaceutical R&D has risen at a faster pace than that of most other countries. In 1978, all told, Japanese firms accounted for only 15 per cent of the worldwide total spent on pharmaceuticals development, less than that of the Swiss industry. In the early 1980s, the Japanese pharmaceuticals industry accounted for 23·1 per cent of all new drugs introduced on the worldwide market, rising to 35·4 per cent in 1983.

The US's pharmaceutical industry has been spending about twice as much as the Japanese industry to develop only about one-third as many new products. The R&D activities of Japanese firms would appear to be six times as efficient as their American counterparts. Reasons for this are not difficult to discover:

- Japanese firms seem to direct more resources to applied research, with an emphasis on producing a marketable product. As many as 75 per cent of all pharmaceutical companies are engaged in research into monoclonal antibodies. A large portion of this work is reportedly focused on developing anti-cancer agents, monitoring bioprocesses and recovering proteins.
- Bulk pharmaceuticals are produced by food and beverage companies with long experience and people highly qualified in bioprocessing. These firms are big enough to obtain economies of scale and learning in the production stages, which markedly improves the economies of marketing new products.
- These firms tend to rely largely on conventional microbiology, genetics and bioprocess feedstocks. But the high level of their bioprocess engineering allows speedy assimilation of new developments in biotechnology, and facilitates the introduction of state-of-the-art technology.
- R&D itself tends to be more efficient in cooperative arrangements within and among firms. The lifelong employment system has a dual effect. It promotes company investment in the continual training of engineers and scientists, and the cooperative skill of management within the company fosters teamwork that brings the best out of everyone. Joint research projects and collaboration between companies, sometimes with government prompting, tend to reduce the risks of basic and generic applied research stages. They also promote diffusion of the results throughout the industry and thus accelerate the pace of innovation.

At least 60 firms reported cooperative links with other firms in 1982, 45 of which were involved in joint R&D projects. But as many as 116 were involved with research institutes or universities, including the exchange of personnel for special projects and advanced training. Most Japanese companies engaged in biotechnology cooperate with leading foreign firms, especially for the transfer of rDNA technology. Most of these arrangements are with biotechnology firms in the US and take the form of licence agreements, joint ventures, or R&D contracts under which a flow of technology to the Japanese firm is assured. Japanese companies, in turn, conduct tests for new pharmaceuticals, obtain government approvals and undertake marketing in Japan.



From development to marketing

What tends to happen is this: the US or European biotechnology firm develops a microorganism and the related bioprocessing, extraction and purification processes needed to produce enough of the desired product to test. The Japanese company then takes responsibility for producing and marketing the new drug.

The annual rate of growth for products of biotechnology is likely to be over 16 per cent until 2000. Many Japanese firms in basic materials and depressed sectors, such as synthetic fibres, see in biotechnology a new hope for survival and growth. But, because few are able to marshal all of the technical resources necessary for a complete R&D programme in biotechnology, domestic and international cooperative arrangements have become essential to enter the marketplace. In Japan, cooperation between drug and non-drug firms to bring a product from the laboratory to the market often stops just short of a merger, to make the most of the advantages of integration.

While such integration would probably lead to merger or acquisition in most countries, the fierce independence of individual firms, even those members of large industrial groups, prevents this in Japan, except when necessary for survival.

The 1982 *Keidanren* survey shows that the number of Japanese firms employing more than 10 researchers working on rDNA projects jumped from no more than 10 to as many as 52 in the short span of a year. Very little of this increase was accounted for by outside recruitment. A shortage of biological scientists graduating from universities, combined with the almost total absence of a floating labour market, made necessary the in-company retraining of biotechnical personnel. The lifelong employment system, in turn, forced the process in diversification of companies into biotechnological applications to assure employment of their members. Alongside this, the heavy investment necessary for their retraining was possible without the risks that are inherent in a system used to high employee mobility between companies.

It is this dynamic process that makes Japanese bio-industries so energetic, adding to the formidable advantages of long experience in bioprocessing engineering and the ability to finance sustained investments in new technologies. To this must be added, as an exponential multiplier, the emphasis universities give to the retraining of bioprocessing engineers.

Inadequacies in basic biological science in many universities have led to a shortage of experts in genetic manipulation. Yet, Japanese universities have been able to respond to the continuing needs of chemical, food and beverage industries for specialists in traditional bioprocesses, specialists now essential to commercialise new biotechnologies. Their American counterparts face serious shortages of both bioprocess engineers and industrial microbiologists.

The shortage in the US had become apparent, as early as 1973, prompting a leading American scientist to lament that, unless things changed, it would be necessary to send students to Japan to learn the techniques necessary for the fermentation industries to survive. According to the OTA's report, however, no such change has taken place.

In the short run, this complementary structural imbalance in human resources—shortages of biological scientists in Japan and bio-engineers in the US and Europe—would seem to augur well for cooperation. But moves are noticeable, in Japan at least, to correct the shortage of biologists. Larger, established Japanese companies sponsor overseas training of their technicians in an effort to meet the demand and promises of the biotechnological revolution. At present, more than 60 per cent of all Japanese firms applying biotechnologies send some personnel abroad for training in specialised technologies. Few, if any, American companies are taking advantage of available training facilities in Japan to correct their critical shortage.

In many ways, therefore, the situation in biotechnology resembles the microelectronics scene of the late 1960s. At that time, the lead of the US's specialised semiconductor manufacturers seemed invincible. But the acute shortage of electronic engineers combined with the high cost of capital and instability within venture capital companies to restrict the high level of innovation required. The result, plainly evident, has been the heavy loss of the US's share of the semiconductor market.

In the US, the much weaker generation of new biotechnology firms is now confronted with the same prospect of shortages of staff and money. Both assets are more readily available to established and more highly integrated Japanese firms with long experience in bioprocess engineering on which to build rapid future growth. Unless these gaps are filled, a repetition of the patterns of change in the electronics industry would seem a foregone conclusion. The past would indeed, in this instance, be prologue. ☐

Gene Gregory is professor of international business at Sophia University, Tokyo

He likes to see all the brothers together. But does he know which novel has Big Brother watching?

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Neptune robots are sold in kit form as follows

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Neptune 1 simulator	£45.00	Gripper sensor	£37.50
		Optional extra three fingered gripper	£75.00
Neptune 2 robot kit (inc. power supply)	£1725.00	BBC connector lead	£12.50
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Neptune 2 simulator	52.00	Sinclair ZX Spectrum connector lead	£15.00

All prices are exclusive of VAT and valid until the end of March 1985

mentor
desk-top robot

This compact, electrically powered training robot has 6 axes of movement, simultaneously servo-controlled. It gives smooth operation, and its rugged construction makes it ideal for use in educational establishments. Other features include long-life bronze and nylon bearings, integral control electronics and power supply, special circuitry for inertial compensation, optional on board ADC and hand-held simulator as the teaching pendant. Like Neptune, Mentor's program length is limited only by your computer's memory. Programming is in BASIC.

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BBC connector lead	£12.50
Commodore VIC 20 connector lead and plug-in board	£14.50
Sinclair ZX Spectrum connector lead	£15.00

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Test-tube babies in the zoo

The new 'reproductive technology' may help us preserve threatened wildlife through artificial breeding in zoos

Jeremy Cherfas

Zoological Society of London

Tarot, the first "test-tube" Przewalski horse, was born in June, this year, to his surrogate mother, Honey Pot. Week old blastocysts are taken from donor mares, and implanted into donkeys and ponies

"LITTLE did the people on the plane know they were riding with a herd of bongos." Dr Betsy Dresser, director of research for the Cincinnati Wildlife Research Federation, was describing a flight she had taken from Los Angeles to Cincinnati. And even if they had known that the bongo is a shy antelope native to the forests of central Africa, there would be no reason for the passengers to be concerned about the cargo on an ordinary flight. A search of the hold would not have revealed anything out of the ordinary either, for the herd of bongos was contained in a couple of test tubes taped to Dresser's body; the animals were present as 100-cell embryos.

On arrival at Cincinnati the bongos continued their journey to the zoo there, where each of the healthiest ones was placed into the womb of a waiting eland. Some nine months later an eland cow delivered herself of a healthy 20-kilogramme bongo calf in under 14 minutes. An eland calf is twice that size. "It was so easy," said Dresser, "next year she'll get twins."

It was a first, of kinds. The dairy industry had been transferring embryos between cattle since the 1950s. New York Zoo had already successfully transferred an embryo from a gaur, the largest of the wild cattle and endangered in its native India, to a dairy cow, but the gaur had been placed in the cow through an incision. At Cincinnati no incision had been used; it was the world's first non-surgical embryo transfer between exotic species.

On 14 October 1984, Cincinnati may have scored another first with the birth of an eland. She had been removed from her mother after seven days' gestation, frozen solid in liquid nitrogen for 18 months, thawed, and implanted into a waiting eland cow. This calf finally saw the light of day some 27 months after conception, as opposed to the customary nine. Whether this was a first or not is open to interpretation because London Zoo witnessed the birth of two once-frozen marmosets some six weeks earlier, on 4 September. But London's marmosets had been frozen for only a week. So Cincinnati's eland went in the freezer first and was implanted first, although London's marmosets were actually the first frozen exotic embryos to be born, about a dozen years after Frostie, the first frozen dairy cow.

Dresser's success is fitting as it was at Cincinnati Zoo that the final members of two species, the passenger pigeon and the Carolina parakeet, breathed their last. It is also representative of the fertile new field of artificial breeding in zoos, a major topic at the 4th World Conference on Breeding Endangered Species in Captivity, held recently in the Netherlands. Embryo transfer, artificial insemination, and cryopreservation, having become almost routine in the breeding of domestic livestock and the treatment of human infertility, may now help us to preserve threatened wildlife.

Embryo transfer between species is a very valuable enterprise. The idea is to use females of a relatively common species as surrogate mothers for a more endangered one, the equivalent of the bird world's double-clutching. If one removes the eggs from a pair of birds, the female will generally go on and produce another clutch. The first lot can be artificially incubated, thereby doubling an individual's reproductive output. In the case of the Californian condor, scientists have managed to remove and raise three eggs from one pair in a single season. As the birds normally produce only one young every two years this is a six-fold increase. With mammals it is possible to multiply the success even more by using fertility hormones, and Dresser has collected 31 embryos from a single eland instead of the usual one.

Embryo transfer is not so much a single dramatic operation as the successful culmination of a plethora of little manipulations, each timed correctly and each depending on the preceding one having worked. The most important aspect is

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to know the reproductive biology of the species, and it is no accident that the very first transfers in the zoo were of gaur and zebra, close relatives of the domestic cow and horse. For example, it is vital that the donor and recipient be synchronised in their reproductive cycles so that the embryo will find a welcoming womb. Normally this is done using a technique developed on domestic livestock; give the animals a precisely timed injection of a prostaglandin. Prostaglandins are used in "morning-after" pills, and they work by kicking the ovaries into a new cycle, which will be synchronised in the two animals. So far this approach has worked in zoo species too, but as the zoo breeders move further from the safety of known domestic species the odds are that problems will arise with, say, dosage or timing.

The donor animal is usually covered in the traditional way by a male of proven ability, but in order to make the whole process more worthwhile she is generally superovulated. That is, she is given a hormone cocktail designed to stimulate her ovaries into producing considerably more eggs than the one or two of a natural cycle. This works well with ungulates. as Dresser's record of 31 eggs from one eland cow indicates, but is more of a problem with equids. The fertility hormones are derived from pregnant mares, and when given to zebras or Przewalski horses they have no effect.

With the donor successfully mated, and the recipients standing by to receive the transplants, it is time to go looking for the embryos. These are generally left to develop for about a week. At this stage they have emerged from the surrounding layer of cells that accompanies them down from the ovary but have not yet implanted into the wall of the uterus. With the animal under anaesthesia the zoo vet inserts a balloon catheter into the donor's uterus. When inflated the balloon seals the neck of the uterus. A specially formulated washing fluid, mostly a phosphate buffer, is poured through the catheter, about six litres for a mare. The balloon is deflated and the washings collected. Somewhere in the six litres, among the cell debris, will be the tiny blastocyst, no bigger than a full stop.

Male gorilla, born in June this year, after artificial insemination of a non-breeding pair of gorillas at Melbourne Zoo

David Higgins

The success record for embryo collection so far seems to be good, although there is no standard to compare it with and one never knows whether failure represents failure to collect an embryo or failure to find it. Over the two seasons of 1983 and 1984 London Zoo's Institute of Zoology made 43 attempts to collect embryos from zebras and Przewalski horses, and succeeded on 25 of them.

Once the embryos have been found and inspected to see that they are healthy, there are two options. Either they are frozen for storage or they are implanted as soon as possible. This often involves a journey, though not usually as far as Los Angeles to Cincinnati. For Philip Summers and his colleagues at London Zoo it means a drive to the Thoroughbred Breeders Equine Fertility Unit outside Cambridge. The blastocysts, Przewalski horses and zebras so far, make the journey in Summers' shirt pocket, and are implanted in ponies and donkeys respectively. The first success, a Przewalski colt called Tarot, was born on 8 June 1984 to a New Forest pony called Honey Pot. The first zebra unfortunately aborted late in gestation.

Embryo transfer began, not surprisingly, with the relatives of domestic animals because so much money had already been spent on finding out about those species, but it is now slowly being extended further. Dresser began her work by transferring eland to dairy cattle, but all the embryos failed. That was why she switched to using eland themselves, first for other eland in the experimental phase and then for bongo.

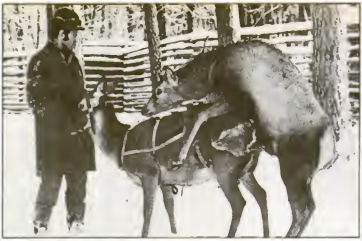
At the moment there seems to be a limit as to how distant, evolutionarily speaking, donor and recipient can be. All the successful transfers to date have been between very closely related species, often members of the same genus. A new approach, however, threatens to breach even this barrier to artificial breeding, as Philip Summers told the conference. One of the reasons that cross-genus fostering fails is that the placenta, which supplies the developing embryo with nutrients from the mother's bloodstream, fails to form properly. Part of the cause may be an immune reaction between the mother's cells and those of the donor embryo, which is even more foreign than a natural embryo. To overcome this, reproductive scientists have taken advantage of the fact that they can distinguish those cells that will form the placenta from those that will form the embryo itself even in the very small blastocyst.

The outer layer of cells is the so-called trophoblast, which will form the placenta, while within the trophoblast is the inner cell mass, which develops into the embryo and its associated membranes. By carefully splitting open a blastocyst and removing the inner cell mass, scientists at Cambridge and in West Germany have been able to transfer the inner cell mass of a goat blastocyst into the emptied trophoblast of a sheep. Implanted into a sheep, the chimeric blastocyst went on to develop normally and eventually resulted in a healthy pure-bred goat being born to a sheep. Goats and sheep are in different genera, and a straightforward embryo transfer between them fails. This technique might be adapted by zoos to breed endangered species that have no available host sufficiently closely related to carry an implanted embryo.

Embryo transfer is perhaps the most glamorous of the techniques of artificial breeding, and one with great potential. Artificial insemination is already routine for a plethora of species, not only mammals but birds too. Again, the techniques are derived from agriculture, where artificial insemination, coupled with semen banks for long-term storage, has enabled individual males with desirable qualities to sire truly vast numbers of offspring. In zoo breeding the

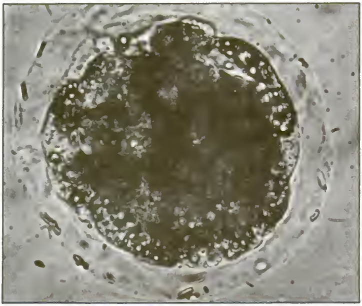
Dr Betsy Dresser, Cincinnati Zoo

This eland calf at Cincinnati Zoo was born 27 months after conception. The embryo was kept frozen for 18 months



B. Gatcka/Zoological Society

Semen collection from a stag: artificial hind-quarters are fixed to a "teaser" doe with a harness



Dr Betsy Dresser, Cincinnati Zoo

The week-old embryo of the eland calf kept frozen for 18 months. The calf (above left) was born in October

aim is to minimise any form of selection, but artificial insemination still has its uses.

Perhaps the most important is that it obviates the need to transport animals in order to fulfill the requirements of a rational breeding programme. Moving a rhinoceros bull from London to New York could be very important to reduce inbreeding and preserve genetic diversity. Doing it the old-fashioned way is time-consuming and costly, and constitutes a considerable risk. Admittedly there are risks in collecting semen too, but, overall, artificial insemination is much safer and cheaper, although there are problems.

Obtaining the sample is one. Domestic bulls can be trained to mount an artificial cow, but for most exotic species more direct methods have to be used. With birds and some primates and other mammals it is possible to get the animal to ejaculate using manual stimulation, but more usually an electro-ejaculator is used. This is a probe that is inserted into the rectum, where it can deliver gentle electrical stimulation to the nerves that serve the genitals and thus induce an ejaculation. The animal must be under a general anaesthetic to be electro-ejaculated, and that is where the major risk lies. If a male has to be anaesthetised for any reason, the good zoo will often use the opportunity to obtain a semen sample. What happens to the semen next depends on circumstances.

Sometimes the sample is used immediately to impregnate a waiting female. This might be appropriate if the pair will not breed normally. Melbourne Zoo had a pair of gorillas that, while not related, had been brought up together since infancy and regarded one another as siblings to the extent that they would not mate. Melbourne's Royal Women's Hospital leads the world in human test-tube baby technology, and with that expertise available the zoo decided to artificially inseminate the female. She became pregnant, and after a closely observed pregnancy gave birth, on 3 June last, to a healthy baby boy, the first product of artificial insemination in the gorilla to survive.

The infant, yet to be named, was at first rejected by his mother, despite her being given a daily role model in the shape of a representative of the Nursing Mothers Association of Australia, who dutifully breastfed her own son while the gorilla mother-to-be looked on. The gorilla infant had to be bottle fed, but now his mother takes a more active interest in him and zoo staff hope that she will rear future offspring herself.

Melbourne's gorilla breeding is perhaps a special case. More often, artificial insemination is used as a substitute for moving the male. This has been the case with the giant panda breeding programme. When Ling Ling, the female at the National Zoo in Washington DC, came on heat last year zoo officials were disappointed by Hsing Hsing's incompetence. He did mount and seemed to ejaculate, but the staff were not impressed by his performance. National put a call through to London Zoo, where Chia Chia was knocked out and electro-ejaculated. His sample flew off to Washington and was used to impregnate Ling Ling, who gave birth to a cub that unfortunately died of a respiratory failure. Subsequent blood-typing revealed that Chia Chia could not have been the father. For all his apparent incompetence, Hsing Hsing had indeed fathered a panda cub.

Chia Chia had already become a father himself, by artificial insemination. His semen had been used to impregnate Shiao Shiao, the female at Madrid Zoo. She gave birth to a cub who was named Chu Lin, and although she died recently Chu Lin is thriving.

Artificial insemination could also be used to overcome quarantine restrictions and the risks of disease. The biggest hazard is diseases that afflict domestic livestock and are carried by zoo species; brucellosis, blue tongue, foot-and-mouth disease, and the like. Often, agricultural legislation makes zoo transport more difficult and costly than is perhaps strictly necessary, and importing gametes rather than whole animals has been hailed as one way to avoid spreading pathogens. For some diseases this may be true but for others, such as blue tongue, it is not, because the virus can be isolated from semen samples, so even artificial insemination could spread disease.

A further use for artificial insemination is to increase the genetic diversity of the captive population by capturing genes rather than animals. Basle Zoo has already collected semen

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from an African elephant bull in the wild and used it to inseminate a female. She became pregnant, but subsequently lost the fetus.

Artificial insemination and embryo transfer will be very important in the future but at present are hampered most by a lack of basic knowledge. If a zoo wants to interfere with the natural processes of reproduction it must understand those processes in depth. How, for example, are ovulation and pregnancy controlled? Contrary to simple textbook wisdom, there is a bewildering diversity, and what works for one species will not work for another. Keith Hodges at London has discovered that the hormone progesterone, often a reliable indicator of pregnancy, does not rise in the giant panda until the final third of gestation. In artificial insemination, there are hints that sperm collected by electro-ejaculation may not be as virile as that produced in the conventional manner. Is this true, and if so does it matter? The basic research is essential, but is not terribly well supported.

The frozen zoo

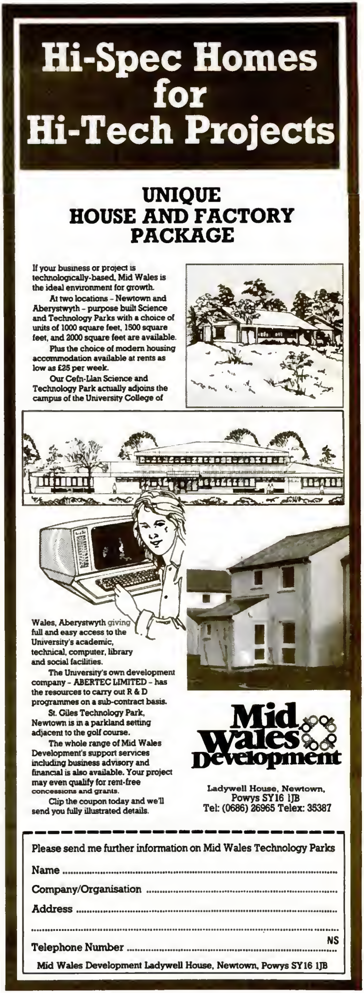
Perhaps the most promising area of artificial breeding is cryopreservation, the frozen zoo. The idea has tremendous appeal; if animals could be kept as eggs, sperm and embryos, preserved at −196° C in liquid nitrogen, the limited resources and space of zoos would be no hindrance to saving many more species. Current estimates are that today's zoos could preserve fewer than a tenth of the mammal species in genetically viable numbers, and mammals attract attention way out of proportion to their biological importance. With cryopreservation, zoos could maintain specimens for display and as eventual recipients in relatively small quantities, while the bulk of the genetic diversity that must be stored could be contained in a few good fridges.

In this area, however, even more than the others, dreams seem way ahead of reality. Despite the few notable successes with frozen embryos and gametes, widespread application is probably still some time away. According to Harry Moore, at London Zoo, of the many species' semen in the frozen zoo, fewer than 20 have been thawed and used to get a female pregnant. Storage conditions for different species differ in unpredictable ways and the few zoos doing research in this field have neither the time nor the resources to investigate systematically. Like many a proud household, zoos freeze many of their leftovers, but few are thawed and used.

As John Hearn, Director of Science at London Zoo, warned the conference, "the electro-ejaculator seems to be the weapon of the modern-day sperm cowboy, who rides the range looking for animals to ejaculate. But what then? There are too many sperm banks that are in fact dead sperm banks." Nevertheless, the hope is that as we learn more, so the frozen zoo will become a useful accessory.

Techniques are being developed to assess sperm viability after thawing without going through the tedious business of a proper pregnancy. Computers can measure the motility of sperm in a sample, which can then be correlated with its fertility, and *in vitro* assessment of the thawed sample's ability to fertilise a hamster egg is also a promising method. In the future it would be nice to discover the secrets of nature's own storage systems. Female reptiles can keep sperm viable in their reproductive tract for up to six years, and a wallaby can hold an 80-cell blastocyst in suspended animation for more than a year.

Artificial breeding will never replace good husbandry and care of captive populations. It will be useful in an emergency to save species that might otherwise go extinct, but as the technology improves I believe that the frozen zoo will become more important as an alternative to the more usual forms of captivity, while embryo transfer and artificial insemination will be used to obey the dictates of the geneticists and studbook keepers. As much as saving species, these techniques could also save zoos by allowing them better to play their important part in conservation. ☐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SCIENCE

Linear programming made simpler than simplex

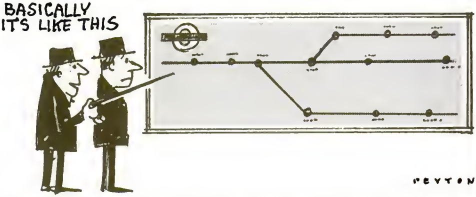
Andy Philpott

BIG BUSINESS, manufacturing industries and military technologies rely on computers to help them find the best solutions to problems involving hundreds or even thousands of variables. But the methods available so far for solving these problems become increasingly cumbersome as the number of variables increases. Now a mathematician at AT&T Bell Laboratories in New Jersey has developed an exciting new method (or algorithm) that should make the solution of such problems, called linear programs, much quicker and easier.

Linear programs are optimisation problems involving large numbers of simultaneous linear equations (equations whose solutions, plotted on a graph, would lie on a straight line). They often arise in applied economics and operational research, in areas such as resource allocation. For example, a factory may manufacture a number of different products, each of which requires a certain mix of raw materials of which there is a limited supply. The problem of finding the levels of production that maximise the factory's profits, while satisfying the constraints on raw materials, is a linear program.

For a linear program with n variables, the set of feasible points (those that satisfy the relevant constraints) form an n-dimensional straight-edged figure (a polytope). The optimal point (the one with the best objective function) is one of the vertices of the polytope, and the object of a linear program is to find it.

Current commercial linear programming codes use a method called the simplex algorithm to find the point. This method was invented by George Dantzig, now at Stanford University in California, in 1947. It involves moving from one vertex of the polytope to an adjacent one with a better objective function, arriving at the optimal vertex after a finite number of steps.



In practice, it happens that the number of vertices visited by the simplex method in solving a typical problem is of the same order as the number of variables. But it is possible to construct examples where the number of steps increases exponentially in relation to the number of variables. In the jargon of computational complexity theory, the simplex algorithm is not "polynomial".

Polynomial algorithms are those that compute the solution to any instance of a problem in a time that is no more than a polynomial function of the number of variables of the problem. (For the non-mathematically inclined, that keeps the number of steps to the solution within reasonable bounds.) For a theoretical computer scientist, this distinguishes the good algorithms from the bad, although in practice the non-polynomial simplex algorithm has worked fairly well.

The possibility of a polynomial algorithm for linear programming was raised in 1979, when L. G. Khachiyan of the USSR showed that a method called the ellipsoid method was polynomial when applied to linear programs. He started with an ellipsoid containing the polytope of feasible points; his method then constructed a sequence of ellipsoids of decreasing volume, each enclosing the optimal vertex. The number of steps this method takes to home in on the optimal vertex is polynomially bounded by the number of variables. But although it is polynomial, the ellipsoid algorithm does not work very well in practice, so up till now the simplex method has remained the most effective algorithm.

Now Narendra Karmarkar has developed an algorithm which is both polynomial and outperforms the simplex algorithm in practice. Preliminary experiments have indicated that for problems with several thousand variables, the new method may be more than 50 times faster than commercial applications of the simplex method. The advantage is expected to grow as the problems become larger.

A host of new applications of linear programming might become possible, including very large models of the economy, and the solution of previously intractable traffic routing problems. Fast implementations of the algorithm might be applied to pattern recognition problems or differential equations, applications that would be useful in missile guidance and other areas of aerospace technology.

What makes Karmarkar's algorithm perform so well? The basic principle is that instead of moving from vertex to vertex of the polytope of feasible points, he constructs a series of points in the interior of the polytope that converges to the optimal vertex (see Box for details).

It is too early to say whether the new algorithm will displace the simplex method as the best for linear programming. ☐

How to out-simplex the simplex method

IN Karmarkar's algorithm, the polytope of feasible points is treated as a subset of a figure called an n-dimensional simplex (nothing to do with the algorithm of the same name). This is an equal-sided figure in n dimensions, analogous to an equilateral triangle in two dimensions or a tetrahedron in three. At each step of the algorithm a projective transformation defined in terms of the point under consideration maps the simplex to itself, while distorting the polytope of feasible points so that the current point is shifted to the centre of the simplex. A sphere, also centred at this point, is constructed lying within the simplex, and a new point is computed that approximates very well to the optimal point in the sphere. Reversing the projective transformation maps this point back to a new current point in the polytope of feasible points. The whole process is then repeated for this point. The successive application of these projective transformations has the effect of magnifying the parts of the feasible region close to the optimal vertex. It is this that seems to give Karmarkar's algorithm its speed. ☐

Californian natives

A CONTROVERSIAL claim that people had colonised North America 17 000 years ago has been refuted by a new analysis of the radioactive carbon-14 in amino acids from human remains found in California.

The original claim was made ten years ago, on the basis of amino acid studies and a calibration date of 17 150 years Before Present for a skeleton found in Laguna Beach, California. Many archaeologists accept, from a variety of evidence, that mankind entered the New World, via the Bering Strait, only about 12 000 years ago. So there was a clear conflict between the amino acid dating and the accepted archaeological evidence.

Something had to give, and that something proved to be the amino acid date. J. L. Bada, of the University of California at San Diego, and others at the Oxford Radiocarbon Accelerator Unit have obtained better dates using tiny samples of organic material at the new Oxford accelerator. Their age for the Laguna Beach skeleton is only 5600 years, bringing the dates for all these remains well into the period corresponding to the archaeological dates (*Nature*, vol 312, p 442). ☐

Researchers refine radiation therapy

THERE are a number of problems with radiation treatment as a way of helping victims of cancer. The first is that radiation does not distinguish between cancerous cells and normal, healthy cells. It will destroy both if they receive high enough doses. The second problem is that cells in the centre of tumours, which are not near a supply of blood, become starved of oxygen. These hypoxic cells are more resistant to radiation than other cells. Radiobiologists believe that these cells survive radiation treatment to live another day, and cause further tumours. Researchers at the Medical Research Council's Radiobiology Unit at Harwell may have partial solutions to both problems.

About 40 per cent of cancer patients receive some sort of radiotherapy. About one-third of these are cured completely; another third lose the original tumour but complications, such as secondary tumours, develop. And in the remaining third the radiotherapy is unsuccessful in destroying the original tumour. Failures often occur with large tumours, possibly because of the resistance of hypoxic cells to radiation. As other cells in the tumour are destroyed, the tumour shrinks and so hypoxic cells become oxygenated and cancerous once more as the blood supply reaches them.

Researchers at the Harwell unit are about to try out a new drug that can make hypoxic cells more sensitive to radiation. They hope it will avoid the problem of previous such drugs, that of being highly toxic themselves.

Clinical trials of the compound, which has no name as yet but is known as RSU-1069, will start within the next year at the Royal Marsden Hospital. It will be several more years before it can be sold as a recognised drug in radiotherapy. But work already undertaken in the unit shows that RSU-1069 is good at catalysing the supply of oxygen to the hypoxic cells.

Not all cancers result in the growth of conveniently-placed tumours. Some, notably leukaemia, produce cancerous cells that are dispersed throughout the body. It is difficult with such cancers to apply radiation treatment so that healthy cells are not destroyed.

In another part of the radiobiology unit researchers have developed a technique for destroying tumourous T-cells in the blood supply of mice. They have done this by combining a source of radiation with a specific antibody that attaches itself to an antigen found only on these tumour cells. Once attached, the radiation emitted from the source destroys the cell to which the antibody is fixed. Normally, mice that have been injected with tumourous cells would die within 60 days. However, 85 per cent of a group of mice treated with the antibody and radioactive source are still alive 200 days after infection.

The source of radioactivity is the radionucleotide Astatine-211, which has a half life of only 7·2 hours. This means more than 99 per cent of its radioactivity has decayed within 48 hours. This is important because Astatine-211 emits alpha particles which have about 400 times the destructive power of beta particles or gamma- and X-rays. With such a dangerous source of radioactivity it is important that the effects do not last for very long.

The antibody that the radiobiology unit has used is anti-Thy 1.1 monoclonal IgG. Similar antibodies for humans are only just being produced. For the technique to work on cancer patients the specificity of the antibody to antigens which are carried only on tumourous cells is crucial. Otherwise the problem of radiation destroying healthy cells crops up once more.

The same team of researchers has found that there are strong similarities between human and mouse genomes (genetic homology). Large segments of chromosomes seem to have been conserved through evolution, so that the position of many genes on a mouse chromosome corresponds closely with the position of similar genes on human chromosomes. This homology is important if radiation experiments on mice are to have any significance for human radiotherapy.

The research team has found that radiation can induce a disease in mice that leads to significant increases in red blood cells, similar to the rare blood disease polycythaemia vera in humans. The team has found that radiation causes a mutation in the gene coding for haemoglobin. This results in a substitution of a single amino acid (tyrosine) for another (cysteine). This in turn reduces the affinity of the haemoglobin for oxygen and the mouse compensates by producing more red blood cells.

Polycythaemia vera was recently studied by the Centers for Disease Control in the US in men who witnessed the detonation of an A-bomb. Out of 3072 men identified from the "Smokey" test of 1957, which involved troops performing manoeuvres near the explosion, the researchers identified three cases of polycythaemia vera, and one suspected case. In a population of this size they would expect to see only 0·2 cases, such is the rarity of the disease. The results were published in the *Journal of the American Medical Association* (vol 252, p 662). The researchers from the Centers for Disease Control think that the possibility that exposure to ionising radiation has caused the disease in the four cases of the study is "tenuous" but "this was the only known risk factor".

They argue that the data on the amount of radiation that the participants of the test experienced indicate that the doses for whole-body exposure were small. However, they say: "Although the accuracy of these data is controversial, they do represent the only available data for external exposures".

They go on to compare their data with those from the studies of the survivors of Nagasaki and Hiroshima. The disease does occur in the survivors of Hiroshima, but not of Nagasaki. However, "the data have been inconsistently gathered, and the cases are too few to draw any firm conclusions about an association with radiation".

The work at the radiobiology unit and the Centers for Disease Control epitomises how much we do not know about the effects of radiation. But radiation, in the right place at the right time, is still a valuable weapon in the fight against cancer. □

Wide-eyed look for interferon

DOCTORS have found an intriguing new use for interferon, the drug once touted as a wonder cure for cancer. A note in the *New England Journal of Medicine* (vol 311, p 1259), reveals that high doses of interferon promoted the growth of eyelashes in two patients. The eyelashes ended up so long that they had to be trimmed twice a week, and led to "numerous comments from admirers".

Kenneth Foon, at the US National Cancer Institute, and Gerard Dougher, reported these unusual side effects in two patients suffering from B-cell lymphoma, a cancer of the antibody-making cells. They received 50 million units of genetically-engineered alpha interferon per square metre of body surface three times a week. Over the six months after treatment started their eyelashes grew thick and curly, ranging in length from 2 to 6·5 cm. This abnormality persisted well into the second year of therapy. □

No ovaries, no PMT

A TEAM from the University of California at San Diego has found that temporarily preventing the ovaries from undergoing their usual monthly cycle reduced both physical and behavioural symptoms of premenstrual syndrome in a small group of women (*New England Journal of Medicine*, vol 311, p 1345). Ken Muse and his colleagues gave the women a drug that blocked receptors for gonadotropin-releasing hormone (GnRH), the hormone that triggers the release of pituitary hormones. These hormones in turn govern the development and release of ova and the secretion of steroid hormones from the ovary.

The drug effectively turned off the ovaries for the six months of the experiment. Compared with an active placebo, it succeeded in reducing symptoms such as headaches, tiredness and violent tendencies that the women had previously experienced before periods.

The research appears to identify the source of premenstrual problems as the cyclic activity of the ovaries (as opposed to diet, low blood sugar or a number of other suggestions). But the GnRH blocker seems unlikely to be suitable for long term treatment; apart from suppressing ovulation and menstruation, it may lead to weakening of the bones due to constant low levels of oestradiol. □

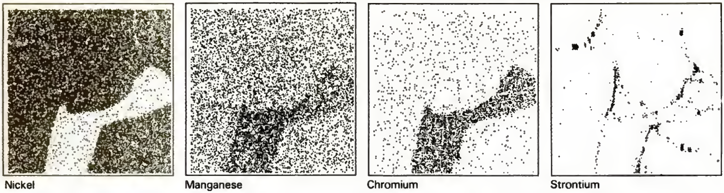
Mad dogs and snake bites

RABIES virus has a lethal affinity for the central nervous system; the virus makes its way through peripheral nerves to the brain where it infects specific groups of neurones. Researchers at Yale University have now produced convincing evidence that the virus poisons the brain by binding to neuronal receptors designed to fit one of the neurotransmitters, acetylcholine (*Science*, vol 226, p 847).

The Yale biologists—Thomas Lentz, Paul Wilson, Edward Hawrot and David Speicher—looked at the glycoprotein that forms spikes on the envelope of the virus and enables it to bind to receptors on normal cells. They then used a computer to compare its structure with the neurotoxic proteins present in the venom of snakes, such as cobras and sea snakes, that act by blocking acetylcholine receptors. The viral glycoprotein and the snake proteins turned out to have identical sequences of amino acids in several regions. The close match makes it very likely that the virus, like the venom, exerts its neurotoxic effect by binding to the acetylcholine receptors of neurones.

Lentz and his colleagues speculate that viruses in general possess structures that are very similar to the domains of molecules that normally bind to receptors on cells. If so, such similarity may form the basis of some autoimmune diseases, such as AIDS. The immune system may respond to a viral infection by producing antibodies that create havoc by reacting with cellular receptors. □

Energetic protons encounter stranded strontium



Chromium and manganese show up in a grain of orthopyroxene, nickel in surrounding olivine. Strontium is confined to the boundary

UNDERSTANDING the way that different elements move around inside the Earth is an important part of studies of how rocks form. Geologists believe that liquids may play a vital role, especially in transporting elements such as strontium that do not occur in the main structure of rock. This view has been strengthened by the work of Donald Fraser and colleagues at Oxford University. They have found direct evidence that strontium collects along the borders of grains of minerals, rather than within their bulk; this in turn implies that the strontium can be easily leached out of the mineral matrix and carried away by liquids.

Fraser has taken advantage of a new diagnostic tool developed by Frank Watt and Geoff Grime in the Nuclear Physics Department at Oxford—the proton microprobe (*New Scientist*, 4 October, p 35). This device scans a specimen with a narrow beam of energetic protons. The protons induce atoms in the sample to emit X-rays at a particular energy for each element. So by measuring the energies of the emerging X-rays, it is possible to map the distribution of elements in the sample.

The proton microprobe is ideally suited to studies of trace elements. The more common *electron* microprobe, which works in a similar way, has the disadvantage that the incident electrons themselves emit X-rays as they encounter the electric fields of the atoms in a sample. This limits the sensitivity of the technique, so that it has proved impossible with electron microprobes to discover exactly how trace elements are located in mineral grains.

Together with Watt, Grime and Jenö Takacs, Fraser has used the proton microprobe to study wafer-thin slices of garnet lherzolite—a coarse rock made from silicates of various metals. In particular, the researchers studied a 4-mm square region containing a grain of orthopyroxene, rich in chromium and manganese but poor in nickel, surrounded by a region of olivine rich in nickel (*Nature*, vol 312, p 352).

The location of the grain shows up well in the microprobe's maps for chromium, manganese and nickel, shown in the figure, where high concentrations appear as dark areas. The map for strontium, however, shows how this element—at a level of a few hundred parts per million—is located along the borders of the grain, and not within the bulk of the two minerals. This, the researchers contend, is strong evidence that the strontium was at one time carried by liquids, when the minerals were still beneath the Earth's surface. Only as the rock finally formed has the incompatible strontium been stranded along the boundaries between the slightly differing minerals. ☐

European tree rings track time accurately

WESTERN Europe at last has its own master tree-ring chronology nearly 7300 years long and linked directly to calendar dates. The completion of the chronology, by Jon Pilcher and Michael Baillie in Belfast and Burghart Schmidt and Bernd Becker in West Germany, is a major event for European archaeology and for studies of past climates and environments (*Nature*, vol 312, p 150). Western Europe now has a chronology for dating ancient objects and events independent of, and almost as long as, the classic reference curve devised in North America from measurements of the growth rings of the bristlecone pine.

With the European chronology complete, all the radiocarbon measurements on oak timbers found at archaeological sites in Europe are now firmly anchored to a calendrical timescale dating back to the sixth millenium BC. (Radiocarbon dates must be adjusted because of natural variations or "wiggles" in atmospheric carbon-14 in the past.) There can now be precise "wiggle-matching" with the radiocarbon calibration curve obtained from the bristlecone pine.

The two dating reference curves are, in fact, broadly similar, even though oaks and bristlecone pines grow at different altitudes in different environmental circumstances and oaks are deciduous whereas the American trees are conifers. But the newly-completed European chronology scores over its US counterparts in its direct association with the very precise radiocarbon measurements made recently on tree-ring dated Irish oak at the Queen's University, Belfast by Pilcher and Baillie's colleague in the palaeoecology centre, Gordon Pearson. These measurements have a small probable error, of plus or minus 20 years. The new calibration curve has better-defined "wiggles" than the bristlecone pine calibration.

The principles of tree-ring dating (dendrochronology) have been established in the US during the past 50 years. The long-living bristlecone pine (*Pinus aristata* and *P. longaeva*) grows at altitudes of about 3000 metres in California's White Mountains and may live for 1000 years or more. By matching ("cross-dating") the year-by-year variations in ring widths in living trees of different ages and in old timber, scientists have gradually built up a sequence of tree rings going back nearly 8700 years from the present. Once this so-called absolute tree-ring chronology was available, direct radiocarbon dating of samples of bristlecone pine wood at intervals down the sequence than provided the key data for checking radiocarbon ages against calendar dates.

Devising a similar tree-ring chronology for Europe has not be so straightforward. One problem is that the growth of deciduous trees at low altitudes and thus the patterns of wide and narrow annual rings in such species as oaks is more variable in temperate regions than in the semi-arid or arid areas of southwestern US.

Another problem for European dendrochronologists is that no European tree has the longevity of the bristlecone pine; pedunculate and sessile oaks (*Quercus robur* and *Q. petraea*) may live for several hundred years, but the average lifespan is only 150 to 250 years. Oak is, however, the timber most often found in archaeological excavations on the continent and is well preserved in peat, so chronologies can gradually be built up by cross-dating many tree-ring records from the historic and prehistoric past.

Since the 1960s, European dendrochronologists at several centres have been constructing independent local oak chronologies of up to 1000 years long or more. These chronologies "floated" until they could be linked to sequences from living trees to form absolute timescales. By 1982, there was a continuous sequence in Germany that extended back 4000 years from modern times but it had a weak link around 550 BC. Ireland's timescale went back further—to more than 7200 years—but it had gaps around 940 BC and between 229 and 13 BC.

The achievement of the Northern Irish/German team has been to close these gaps and to strengthen the weak spots by stepwise cross-dating of oak sequences from Ireland and Germany, with the help of a few floating sequences from England. ☐

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Crystallography reveals the nucleosome's structure

John Galloway

THE NUCLEUS of a typical cell contains a complex of DNA and protein—there is roughly twice as much protein as nucleic acid—to give what is known as chromatin. The DNA carries the cell's genetic information; the role of the protein is more ambiguous, but much of it is probably involved in organising the DNA structurally. As the nucleus contains about a metre of DNA, packed into a space less than 0·01 mm across, the chromatin must be very compact. As it undergoes a complex series of structural changes as the cell reproduces itself, the structure must be readily transformable.

The chromatin seems most likely to be organised in some sort of hierarchy—the protein forming temporary stuctures on to which the DNA sticks, sufficiently strongly to overcome its natural springiness, at the times when it is neither replicating nor being transcribed. It is now certain that at the first level in the hierarchy the DNA is wound periodically on to protein spools, giving a flexibly linked "string of beads" effect. These in turn wind into an irregular solenoid to give the next level. The combination of DNA and protein in each spool is known as a nucleosome. But the detailed structure of the nucleosome has remained a mystery until now. A group of scientists at the Medical Research Council's Laboratory of Molecular Biology in Cambridge has now solved that mystery.

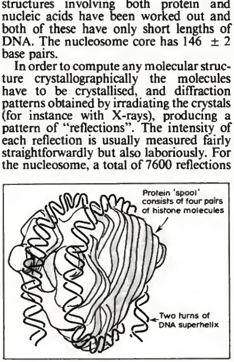
Over a period of about eight years a team led by Nobel prizewinner Aaron Klug has pieced together bits of information obtained by a wide range of methods: X-ray diffraction, image reconstruction following electron microscopy, neutron diffraction, studies of chemical cross-linking and some very ingenious work using enzymes that cut the DNA into pieces whose length can be determined very accurately. The outcome of all this has been a model for the nucleosome in which the double-stranded DNA performs one-and-three-quarter turns around a flat protein core, made up of four pairs of molecules of the highly positively-charged proteins called histones (see Figure).

The problem has been that it was simply a model, and as such had two drawbacks. First, some molecular biologists were sceptical about the eclectic jigsaw puzzle approach, however logically it accounted for the experimental observations. But more seriously, the model alone could not reveal the details of the way the DNA sticks on to the histones. The answer had to be found ultimately by obtaining a high resolution, three-dimensional map of the electron density distribution in the nucleosome, using the sort of crystallographic methods that have given the structure of so many other smaller biological macromolecules.

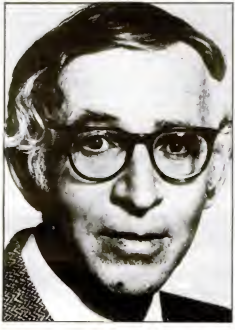
The recent paper in *Nature* (vol 311, p 532) by Tim Richmond, John Finch, Barbara Rushton, Daniela Rhodes and Aaron Klug reports a conspicuously successful attempt to do just that. (In the cause of strict accuracy, what they have studied is not the complete nucleosome but the core—a little of the DNA and a histone is missing.)

The nucleosome presented difficulties as the subject for a head-on crystallographic attack. With an average molecular weight of 206 kilodaltons, divided roughly equally between DNA and histones, it is considerably heavier than any comparable macromolecule or molecular complex successfully tackled. More interestingly, the nucleosomes are not identical. The turns of double-stranded DNA are unique sequences of bases and therefore chemically distinct; and the length of DNA varies among the nucleosomes. Finally, although perhaps a couple of hundred protein structures are known, only two structures involving both protein and nucleic acids have been worked out and both of these have only short lengths of DNA. The nucleosome core has 146 ± 2 base pairs.

In order to compute any molecular structure crystallographically the molecules have to be crystallised, and diffraction patterns obtained by irradiating the crystals (for instance with X-rays), producing a pattern of "reflections". The intensity of each reflection is usually measured fairly straightforwardly but also laboriously. For the nucleosome, a total of 7600 reflections had to be measured for each crystal and the whole process repeated 64 times using different crystals.


Protein 'spool' consists of four pairs of histone molecules
Two turns of DNA superhelix

Structure of the "core" nucleosome now confirmed by Aaron Klug (below) and his team in Cambridge



In X-ray diffraction the intensity of each and every reflection has also to be measured after a process known as isomorphous replacement, in which strongly diffracting groups of atoms are attached to the molecule in order to provide a reference point and overcome what is known as the phase problem. In a very large structure like the nucleosome, the group of heavy atoms must be correspondingly large in order for its effect to be seen. A problem with such heavy atoms is that they are almost always insoluble and before they can be introduced into the crystal they must be made soluble.

To extract the maximum information from the reflections the team adopted an extremely sophisticated approach. Richmond improved the X-ray techniques for recording the reflections and also for analysing them by a method of profile fitting in which he "guessed" the best shape of each reflection using Bayesian statistics. For practical purposes this reduced the number of measurements needed but the price paid was a need for clever computer programming, carried out with the aid of a lot of computing power.

The consequence of a variation in length of the DNA among the nucleosome cores was to alter the intermolecular spacings in the crystals—to use the technical term, the unit cell dimensions varied from crystal to crystal. These dimensions, however, could also be altered by adding a proportion of the alcohol hexanediol to them. It finally proved possible systematically to adjust the crystals until to all intents and purposes they were identical, removing another source of uncertainty.

The fruits of this very considerable and painstaking work over a period of about eight years—the first crystals were made in about 1976 and were considerably improved in 1978/9—have now been revealed in the *Nature* paper. The major features of the nucleosome model are all entirely confirmed, but lots of extra detail is revealed as well: the grooves of the double helix of DNA can be seen very clearly as it supercoils around the core of histones. This establishes firmly what was surprising to many scientists about the model, that the protein was on the inside, not the outside. The importance of the stick-like alpha helix in the proteins is brought home yet again—what are almost certainly alpha helices in the histones make numerous contacts with the DNA. The DNA itself is not smoothly wrapped around the core but is sharply kinked, suggesting that it is pulled more tightly on to the protein in some places than in others.

Linus Pauling defined life as a relationship among molecules. The two key molecules are DNA and protein and in the nucleosome we see their relationship at its most intimate and striking. It is hoped that within a year or so, enough extra data will have been collected to reveal features of individual amino acids in the protein, and bases in the nucleic acids, to give an extremely detailed picture. □

TECHNOLOGY

IBM taps Europe's brains

John Lamb, Rome

IBM, THE AMERICAN computer company, wants to pick the brains of European scientists. Last year Big Blue, as IBM is known in America, produced an average of almost two new products each day and it is now looking to Europeans for fresh ideas.

The company plans to set up a centre for scientific computing in Rome at which researchers who need high-speed computing will have free use of two mainframes and 10 floating-point processors. Floating-point processors are computers designed to carry out complex mathematical calculations.

IBM, which already has 44 visiting professors on its books in Europe, last week also announced its own mini Nobel prize, an annual scientific prize worth some £60 000. It will be awarded each year to a European scientist, IBM staff excluded, who has advanced the progress of science and technology in Europe.

The research at Rome, in fields such as computer science, quantum chemistry, biology and aeronautics will enable IBM to tests its own thinking on the best way to build supercomputers, according to Kaspar "Kap" Cassani, chairman of IBM Europe. Despite its size, IBM does not manufacture supercomputers. "We are now at the point where we can allow scientists to come in and test the future direction [of supercomputing]," Cassani says. IBM is interested in parallel processing, in which computing is done by cooperative groups of processors rather than the single processor found in current supercomputers.

The IBM European Centre for Scientific and Engineering Computing, as the computer centre is called, will have facilities for 15 researchers at a time when it opens next year.

Cassani, who holds sway over 88 000 employees in Europe, is one of the few industrialists who takes an optimistic line about the future of European information technology. Europe's share of the world market for information technology is declining by one per cent each year, according to the European Commission.

"We have an inferiority complex in Europe that is ridiculous," says Cassani. "People say no one but the Japanese can compete, that is not true, Europe is cost comparable with the Japanese."

Cassani has embarked on a series of joint ventures with European organisations to secure components and expand into telecommunications. IBM is particularly keen to set up data networks with European PTTs (national telecommunications authorities).

IBM backs up this activity with hard cash. In 1983, the company spent $1·4 billion on research and development in Europe, over a third of its total expenditure on R&D of $3·8 billion. This research effort is channelled mainly through IBM's seven European research centres.

The company also runs nine scientific centres which work with scientists outside IBM on new applications for computers in research or on longer term projects. For example, the Zurich scientific centre has developed a microscope which produces three-dimensional pictures at an atomic level, using a technique known as scanning tunnelling microscopy. The "microscope" will enable IBM materials scientists to study the surface structure of chips.

A group at the French scientific centre is attempting to help deaf people to lip-read. The deaf can become adept at lip-reading, but there are limitations to the technique. Many sounds look the same when spoken. Most lip-readers probably get only 50-60 per cent of words right. Sounds like b, p and m are identical on a speaker's lips.

Workers at the French centre have developed a number of teaching aids intended to help the deaf to control their own voices and recognise the speech of others.

Among the systems the group has developed is a method of digitising speech and representing its phonetic sounds in a series of symbols. The translation of sound to symbols is done in real time so that it is possible to give lip-readers the extra information they lack.

Looking further ahead the group believes it could be feasible to build a miniature voice recognition system which could be linked to a projector embedded in the frame of a pair of spectacles. The projector would display the phonetic symbols on the surface of one of the lenses, allowing a lip-reader to watch a speaker and get the additional phonetic information simultaneously.

Scientists are also being wooed with equipment that is given away or sold at a discount. IBM has set up a pan-European university network, which spans some 100 universities. EARN (European Academic Research Network) carries messages between researchers.

It is a good investment, because with the rising dollar, IBM is getting more for its money in Europe all the time.

The research laboratories work on projects that are part of IBM's world research programme, but they also do some "freelance" work on products designed for Europe alone. For example, IBM's private branch exchanges, on sale only in Europe, were developed at La Gaude near Nice in France. Software for connecting IBM computers to the packet-switching networks used in Europe was also produced there.

Like all of IBM's research groups these laboratories compete with others in the company working on the same project, but along different lines. As many as a dozen different groups will vie with one another for the privilege of having their research turned into a product.

This process is time-consuming, and IBM is sometimes accused of holding back new technology, which its competitors are already offering customers, in order to make the most of existing products. Tage Frisk, vice president of science and technology at IBM Europe, denies that this is still happening.

"That is not the case now," he says. "There is of course a balance that has to be kept between new technology and service and support. But with products lasting just four to five years we have to be at the leading edge."

Some of IBM's more important products have also come from Europe. The Boeblingen laboratory, near Stuttgart in West Germany, worked on IBM's medium range mainframe computer, the 4300, while Hursley in Britain produces display terminals for graphics work.

But this effort does not cut much ice with IBM's European rivals, many of whom are upset that the company has joined the EEC's Esprit programme of research into computer technology. Cassani maintains that IBM, with its European manufacturing and research, is a European company. "We are as European, if not more European than those who make these statements," he says.

IBM has, however, run foul of the EEC's competition department and earlier this year agreed to adjust its trading practices to make life easier for those who wanted to build IBM-compatible computers, or hook their own machines to Big Blue's. The settlement was made despite considerable pressure from IBM and its Washington allies on the EEC to forget about the complaints it had received from American and European companies.

"It is crucial for us in Europe to unburden ourselves of the self-defeating idea that progress in information technology is a race between nations—a return to the old rivalries which are so detrimental to productivity and competitiveness," says Cassani. □

Software snag for Psion's calculator

PSION, the British software house which rose to fame by writing programs for Sinclair computers, has run into the same kind of problems that have bedevilled Sir Clive over delivering new technology.

Psion makes a pocket computer called Organiser, which costs £100, and uses new memory techniques to store and search through up to 44 000 characters of information. That is the equivalent of 1000 names, addresses and telephone numbers. A liquid-crystal screen displays the information, which stays in the memory even if the batteries die or are disconnected.

However, a vital interface, costing £40, will not be ready until this week, even though Psion has advertised the device widely since mid-October.

According to David Potter, Psion's chairman and managing director, the Organiser comes into its own when used for logging data. Scientists and engineers can take an Organiser to the field or laboratory, and then dump data into an office computer through a standard RS 232 interface. The interface saves users the need to key the same data into two computers, one portable and one office-bound.

Unfortunately for Psion and customers who answered the firm's advertisements (including a double-page spread in *New Scientist* on 18 October), the company has hit snags in the software needed to control the transfer of data.

Psion says it has now finished testing the programs and will have the RS 232 hardware, software and manual ready for despatch this week.

The problem interface

Barry Fox

Psion claims that the Organiser scores over conventional pocket computers because its memory stores data permanently. The secret is an eraseable programmable read-only memory, or EPROM. It sounds like a contradiction in terms. The apparently impossible trick of altering "read-only" data is performed by a network of silicon junctions. In a virgin memory they are all switched into the same state, representing either ones or zeroes of digital information.

The central processing chip in the Organiser, an 80-pin, 8-bit microprocessor made for Psion by Hitachi, sends a serial stream of data signals to the EPROM. These signals progressively switch the memory's junctions to create a semi-permanent binary record.

This record can be erased by sending further signals which switch fresh junctions to create different paths which over-ride the record stored previously. Gradually, the memory is eaten away until there is no room for further restructuring.

The chip is then placed inside a "formatting cabinet" and bathed in ultraviolet light for half an hour. This returns all the junctions to their virgin state, erasing all previously recorded data and leaving the chip ready to start recording a fresh batch. Each chip can be erased and re-formatted up to 100 times.

The Organiser has sockets in its side for two EPROM cartridges which will store up to 44 000 characters of text. When the device is in use, data run continuously in a loop through the cartridges so that they play the same role as floppy discs do in conventional computers. □

Light phone for hostile environments

A SMALL COMPANY in the US is offering for sale a telephone that is hooked up via optical fibres. At $499, the "light" phone is not intended as a spare for a guest room. However, American Photonics Inc of Brookfield Center, Connecticut says the fibre-optic phone can be used in many places where ordinary phones do not work well.

The phone looks like a standard desk telephone, but is connected to telephone lines by an optical-fibre cable that can be up to a kilometre long. Inside the telephone and on the opposite end of the cable there are interfaces that convert standard telephone signals into pulses of light. Power to run the phones comes from a wall plug or battery instead of over the telephone lines, as happens with ordinary electrical connections.

A major use of the fibre-optic phones is likely to be in "screen room", where metal shielding is required to protect electronic instrumentation against heavy levels of electromagnetic interference. Screen rooms may be needed in power plants or in factories with heavy electrical machinery.

The screening protects electronic equipment from strong electromagnetic fields which could induce currents in wires and scramble signals. The strong interference makes it impossible to string telephone wires to the rooms, so some screen-room occupants have had to literally pull (nonmetallic) strings to communicate with the outside world.

Like strings, optical fibres are nonconductive, so they can carry signals to and from the screen rooms without interference. □

Disaster simulation

COAL, IRON ORE and fertilisers are among the cargos of bulk carriers which can become hazardous in rough weather. If such cargoes, containing more than a certain amount of moisture are shaken violently, the apparently dry particles change into a sticky mass which can flop from one side of the hold to the other and cause the ship to list.

The problem has been tackled by Dr Pat Green at the Warren Spring Laboratory at Stevenage. She uses a ship simulator which swings samples of cargoes around in a way that simulates cargo movements in bad weather.

The simulator can impart heave, roll or pitch. The International Maritime Organisation is now using Green's findings to draw up new rules for ship's masters to follow. □

Acoustic amplification gives smaller loudspeakers

BOSE, AN ELECTRONICS firm in the US, has turned accepted loudspeaker technology on its head to develop a new sound reproduction system. It produces a loud sound with strong bass, from a small and light cabinet, while drawing relatively little power from an amplifier.

Normally, meaty bass is obtainable only from a large, heavy cabinet which converts the electronic input signal into sound energy. If a small cabinet is used it must normally be driven by a powerful amplifier which compensates electrically for its acoustic deficiencies in the low frequency range.

Dr Amar Bose is the company chairman and professor of electrical engineering at the Massachussetts Institute of Technology. He says that the unit is the result of 14 years research, and that it compensates acoustically for small cabinet size, and can be run on batteries.

The Bose trick is to rely on standing waves caused by reflections in a pipe. These waves resonate at certain frequencies, and this amplifies the sound. This is how an organ pipe works. But an organ pipe resonates at a fixed frequency and amplifies only one note. This is useless for a loudspeaker, which must reproduce a wide range of musical notes without undue emphasis on any. About five years ago, Bose found that if he mounted a loudspeaker part way along a pipe, instead of at the end, as in an organ, the resonances could be spread over a wide range of frequencies.

Using computer analysis of the standing wave pattern, he found that at a golden ratio of 3:1 there was a remarkable effect. At the two open ends of the pipe there is a radiation of sound with acoustic amplification at frequencies between 50 and 700 hertz.

Because the speaker is mounted part way along the pipe, sound is being radiated in both directions by its cone, but in opposite phases. Because of the different lengths of pipe on each side of the speaker, each section sets up its own pattern of standing waves. These bring varying patterns of resistance to bear on each side of the vibrating cone.

This constantly changing pattern of resistances limits cone motion at some resistances more than others. Sound with different resonant patterns is constantly radiated from each end of the pipe. The aim is to get the different patterns to provide an overall output which has no nasty resonant peaks outside the 3-octave band. A computer is needed to work out how all these variables can be matched, and the golden ratio of 3:1, used by Bose, was a result of working through all the mathematics. The unit will go on sale in the US this month. □

From the laboratory to industry

Stephanie Yanchinski

ONE OF THE KEY blocks to biotechnology remains locked in the mysterious process of "scaling up". This is according to Dr Malcolm Stewart, director of the biotechnology unit of John Brown Engineers and Constructors, the company which helped design the largest continuously running fermenter in the world for ICI.

Stewart says that, unlike conventional chemical processing, "we cannot model biotechnology processes mathematically" and "in particular we are a long way from predicting the behaviour of the new, genetically engineered microorganisms".

Scaling up is the process of expanding production from a small experiment done in a 10-litre flask on the bench top, through an intermediate pilot-plant stage to a fully-fledged, computer-controlled production process which is carried out in fermenters with a capacity of hundreds or thousands of litres. As Barry C. Buckland, of Merck Sharp and Dohme Research Laboratories points out: "The difficulty of scaling up stems from the fact that there are so many chemical and physical variables which can alter the metabolism and morphology of the microbial cell."

Professor Derek Ellwood, head of pathogenic research at the Centre for Applied Microbiology Research, at Porton Down, says the problem is much more fundamental. He points out that microbes behave quite differently when they are packed closer together, as they are in commercial fermentations for increasing yield.

Biotechnology shares some of the problems experienced by the conventional antibiotic industry in designing processes. One key problem, says Stewart, is maintaining a homogeneous mix of oxygen and nutrients to ensure each cell receives its due share. Another is to remove the products, which can sometimes be toxic to the cell, quickly. For example, home-brewers know that when their beer gets beyond a certain strength, the yeast dies. Now industrial fermenters are on the drawing boards that will strip out ethanol produced by yeast fermentations before it can poison the cells.

Dissipating the large quantities of heat generated during the fermentation before the high temperatures kill the cells is another problem complicated by scaling up.

Currently this is done by either running cold water through a thin cooling jacket on the outside of the fermenter, or through a coil inside. But the coil corrodes, leaking cooling water which spoils the broth.

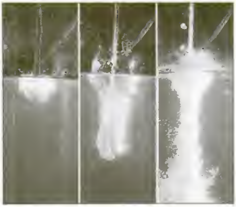
However, the gene-spliced organisms which are at the heart of the new biotechnology processes pose special difficulties. Maintaining sterility is critical with genetically engineered microorganisms. They are vulnerable and inherently unstable. "You end up designing for the ultimate level of protection", says Stewart.

For its new Pruteen plant, ICI filed more than 100 patents on equipment, down to especially smooth valves which would not harbour bugs. The result is the largest fermenter in the world which can run for months at a time without emptying and cleaning.

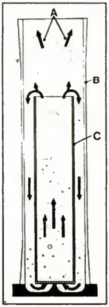
Then, too, genetically engineered microbes tend to regress back to normal and lose their genetically engineered properties. "There must be more precise control of key parameters such as oxygen and nutrient levels," says Stewart. "Such control will probably involve more extensive use of computers, allied with new types of biosensors". The Japanese already have biosensors to detect levels of penicillin.

Genetically engineered cells need a lot of oxygen while they are growing. Stewart says that the conventional paddle-stirred fermenter is not very efficient at delivering oxygen to the cells. ICI says that its designers did not even consider a conventional paddle-type stirrer, because the energy required for driving the large motor would have been prohibitively expensive, and the motor posed additional sterility problems.

Newer designs incorporate rising air bubbles to mix the broth, which has a consistency of porridge. These can be run on an enormous scale, as in ICI's Pruteen plant.



Oxygen is jetted into the fermenter



Oxygen entering a fermenter through nozzles at its base

However, even more efficient systems are needed, and John Brown Engineers and Construction is developing another design with a Hungarian university. The "high-turbulence plunging jet" works by recycling part of the broth onto the surface of the nutrient broth in the fermenter as a high-powered jet. This jet plunges into the broth, "entraining" a lot of oxygen as it moves downwards.

John Brown has conducted studies on organic solutions which show the transfer rate of oxygen can be improved 10 times with its jet system. Other studies, evaluating production of enzymes by microbes, showed that the yield normally produced in 120 days with a conventionally stirred reactor was achieved in 90 days with the jet system.

If products from biotechnology are to compete at the bulk end of the market, some way will have to be found to improve yields, while reducing costs. This can be done by improving the balance of the energetics of the process—getting more product for less energy. For example, ICI vastly improved the utilisation of feedstock and thus the economics of its process by incorporating thousands of tiny nozzles to inject the feedstock into the broth.

Another way to improve the energy equation is to extract some of the product while it is still in the fermenter by installing an ultrafiltration system consisting of a series of membranes.

One way to improve the energetics could be to add a chamber which contains the membranes, through which the broth and products could be continuously circulated. The American manufacturer Millipore is looking at such systems.

Even more intriguing is the work of Henry C. Wang, who has tested resin particles at the Department of Chemical Engineering, at the University of Michigan. He found that these particles pull away product from gene-spliced bacteria and can be sieved off. Wang claims higher yields and better overall extraction for his system. But this system is not yet commercial, says one British expert, because the devices tend to clog up.

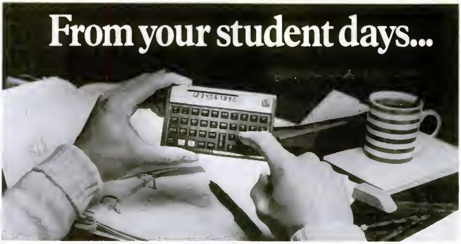
However, with biotechnology, even more than with antibiotics, the real cost lies in recovering products. This can account for between 80 and 90 per cent of production costs. For small quantities of high-value pharmaceuticals, which are usually produced in batches, companies can afford to install a sophisticated purification system specially tailored to their needs.

However, Ellwood says that purification systems do not exist for the production of bulk products such as organic chemicals. Such purification systems will have to handle large volumes of material rapidly, and operate almost continuously over long periods in order to be economic.

The UK Atomic Energy Authority has one of the most advanced systems for bulk purification. The American firm Millipore is perfecting high-performance liquid chromatography.

Burroughs Wellcome says it has perfected a way of making and purifying human interferon in batches of 8000 litres. The secret, says Dr Norman Finter, is keeping the process highly sterile.

Stewart, however, thinks that organic acids made by fermentation may require only standard recovery processes. Distillation, drying and precipitation are techniques already at work in the chemical industry, and they "will find as much use in the fermentation industry". □



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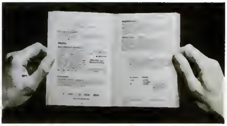

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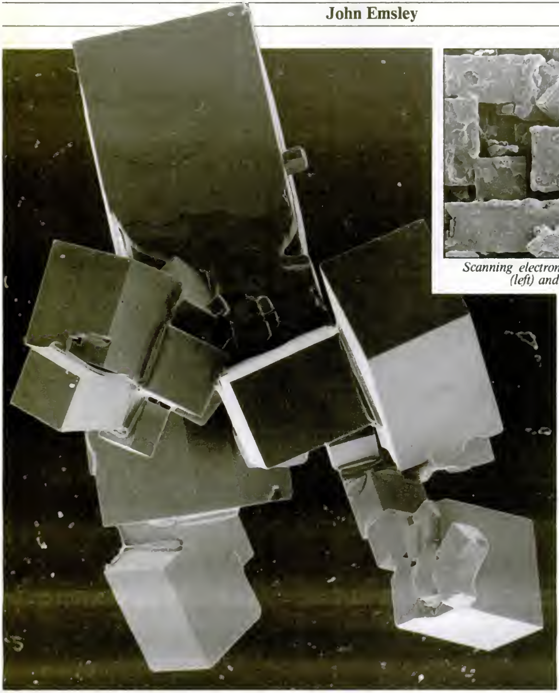
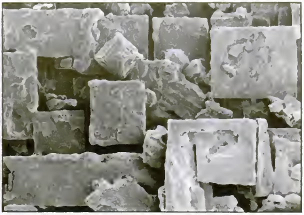
HEWLETT PACKARD

There is no substitute for salt

However we feel about salt in our diet we cannot live without the sodium it contains. Our bodies use this to transmit information rapidly along nerve cells, and to do this they have devised some very curious molecules. Chemists are now finding ways of using their own versions of these compounds

John Emsley





Jeremy Burgess/SPL

Scanning electron micrograph of sodium chloride (left) and Maldon Sea salt (above)

Impurities often disrupt the basic cubic structure of salt giving rise to lattice defects and dislocations

SODIUM is so important to our wellbeing that we have the innate ability to recognise the taste of its most important compound, sodium chloride or salt. Perhaps this is not surprising, because life evolved in a salty environment, the sea, and it has even been said that the composition of blood plasma reflects the ancient Cambrian seas at a time when organisms with blood streams first developed. Since then the seas have become more concentrated and the land-areas of the planet have become correspondingly depleted in sodium salts. Animals have thus developed an appetite for salt and an ability to sense it.

Humans, however, have got things slightly wrong. Although we can recognise salt, we lack the ability to regulate its intake according to our body's needs. We do not *crave* salt even when we really need it, such as following a dangerously heavy loss through sweating or diarrhoea. Little wonder then that our feelings towards salt have always been rather confused; more emotional than rational.

Until the industrial revolution and the development of salt mining, salt was scarce and a highly valued commodity. Evaporating sea water or brine from natural springs was the main source of salt, and evidence for this activity has been found in prehistoric sites all over the world, from Cheshire to China.

Salt has been taxed and wars fought for its control. The British empire began its rapid decline partly as a result of popular unrest in India, its hottest and most important colony, over a quite unnecessary tax on salt.

Although salt is now cheap and plentiful throughout the world, it still plays an important part in our everyday life. Some people think that too much salt in our diet is harmful. Others disagree. Whatever we feel about it, we cannot deny our bodies the large amount of sodium we consume each year, because this element is essential to life. But why do we eat four kilograms a year of sodium chloride when even the most active person needs only a quarter of this amount?

There are several natural sources of sodium in our diet, such as meat, fish and eggs. Even the water we drink contains some dissolved sodium salts. But the most important source

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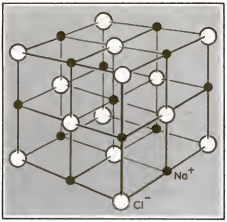
Datasheet on salt



Chemical name: sodium chloride
Chemical symbol: NaCl (Na from Greek *natron*)
Crystal structure: Cubic
Solubility in water: 359 g per litre at 20° C (brine)
Solubility in hydrocarbon solvents: nil
Melting point: 801° C
Industrial uses: electrolysis of molten NaCl gives sodium metal and chlorine gas; electrolysis of brine gives sodium hydroxide and chlorine

Tim Moore

today is common salt from salt mines. Salt intended for human consumption must be at least 99·6 per cent sodium chloride (British Standard BS998). The main added impurities are sodium sulphate and some magnesium chloride which, being hygroscopic, keep the salt free-flowing in damp weather. Other kinds of salt such as sea salt are essentially no different, except in price.

The average person weighing 70 kilograms contains 100 grams of sodium, equivalent to about 250 grams of sodium chloride. Of this, 125 grams circulate in the blood, 100 grams are in the skeleton and 25 grams within cells. To maintain this sodium in the face of unavoidable loss in sweat, faeces and urine, we need a daily intake of three grams of salt. But we can get by with less than one gram provided our body is not under stress from excessive sweating or diarrhoea. Nor is too much salt a problem as it is easily excreted. A single large dose acts automatically as an emetic.

Throughout the world, there is a tremendous variation in daily salt intake. The natives of the New Guinea highlands have the lowest of any: 0·1 to 0·5 grams per day. At the other extreme, the people of northern Honshu, Japan, consume on average 30 grams (one ounce) per day. The amount we take in the West is about 10 grams, which is three times what we need even if we do hard physical work or take strenuous exercise. This poses a problem for us, because high salt intake may be linked to high blood pressure.

Nearly 40 per cent of those salt addicts in Honshu have high blood pressure and a correspondingly high death rate from strokes. Similar correlations between high blood pressure and high salt diet have been made for American blacks. In New Guinea, on the other hand, only 3 per cent have high blood pressure. But what is more unexpected is that those over 30 experience *decreasing* blood pressure with age. This is quite the reverse of the trend in the West, where there is a direct link between age and blood pressure, and where over 10 per cent of the population has high blood pressure. The best researched group, the Yanamamö natives of the Amazon, have the same low salt diet as the New Guineans. In addition they are extremely aggressive yet show no high blood pressure symptoms nor any change linked with age.

The logic of these observations is that too much salt over many years leads to high blood pressure. Why, then, do we eat so much salt? The answer is that we like its taste, either directly as in salted snacks, but mostly indirectly in those foods, such as bread or margarine, that are unpalatable without it.

An appetite for salt may develop when we are young, perhaps even as a baby when we might have been fed on cow's milk, which has a much higher salt content than human milk. Cows are encouraged to lick salt to increase their water intake. This prevents them being adversely affected by silica present in grass. Modern baby foods now contain much less salt, although they still provide more than a baby needs. Reducing the salt intake of babies in this way seemed to show no noticeable effect on blood pressure, but a more stringent experiment appears to demonstrate such a link. This was established by Albert Hofman and his co-workers at the Erasmus University Medical School in Rotterdam. Their results (*Journal of the American Medical Association*, 1983, vol 250, p 370) showed that 231 babies who were given a low salt diet for their first six months of life had a slightly lower average systolic blood press than 245 babies who were fed normally. The same issue of the journal reports a survey performed on the population of Connecticut, showing

Mary Evans

Part of the biggest salt mines in the world at Wieliczka, Poland

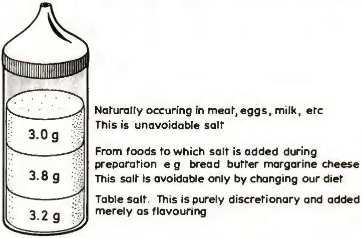


Figure 1 *How our daily salt intake of 10 g adds up*

Sodium in and out of the system

WHY DO we need sodium? Sodium is part of the electrolyte balance, used because it carries a positive electrical charge. In this respect it resembles potassium, and chemically these two elements are very similar, so similar that it requires a lot of skill to differentiate the two when they are dissolved in water. Yet Nature does just this, and has also found a way to move these metals selectively through membranes. How this little miracle is performed has brought new light to bear on the chemistry of sodium. It also brought biochemists and inorganic chemists into close cooperation as they discovered and developed the chemistry of the *ionophores*, the remarkable molecules which are used to manipulate sodium in the body.

To appreciate the problem of moving sodium and potassium through a membrane that is designed to restrict the movement of water we need to look at sodium more closely. Sodium chloride is a salt consisting of positive sodium ions, Na^+, and negative chloride ions, Cl^-. In salt itself these are held together as a perfect cubic lattice by their mutual electrostatic attraction. In forming Na^+, a sodium atom has lost one of its negatively charged electrons, while Cl^- is a chlorine atom that has gained an extra electron. This seeming atomic altruism gives to these elements particularly stable electronic arrangements. They become chemically unreactive, especially when they are dissolved in water.

Under normal conditions nothing can change the chemical nature of sodium ions. Their concentration in water can be changed and this can have dramatic effects, such as the ability of strong brine to kill bacteria, or to attract water through a membrane (otherwise known as osmosis). But nothing changes Na^+ once it is dissolved in water. Moreover, ionic compounds, and sodium chloride in particular, show no tendency to dissolve in organic solvents. This is the real problem, for how can Na^+ be transported through a membrane consisting almost entirely of organic molecules? In other words, how can we get Na^+ to move in and out of cells and, in particular, in and out of nerve cells? Nature had not only to solve this problem, but also to devise a system that would move only the sodium ions while leaving other similar ions, such as potassium, where they were.

Membranes organise living matter by separating cell components from their environment. They consist of lipids and proteins in sheets that are only a few molecules thick. The lipids have water-repelling hydrocarbon tails and water-attracting heads which arrange themselves as shown in Figure 2. Proteins in the membrane serve a variety of functions such as enzymes, receptors and gates. It is with gates as access channels that we are concerned. These are the tunnels along which ions must pass, but down which they are loathe to go because it means shedding their sheath of water molecules and entering an organic environment.

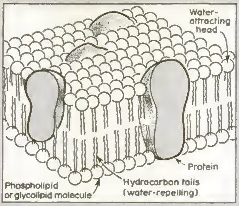

Water-attracting head
Protein
Phospholipid or glycolipid molecule
Hydrocarbon tails (water-repelling)

Figure 2 *Membranes consist of lipids and proteins in sheets*

This step consumes too much energy to occur spontaneously, so what Nature has done is to devise molecules, called ionophores (literally, ion-loving) that wrap themselves around ions, thereby displacing their water coat. They can do this in an energetically favourable manner. These molecules have an organic exterior that makes them happy to move through the membrane's lipid channels.

Several ionophores are known. Most are large ring molecules containing oxygen atoms, and it is these which attach themselves to the sodium ion and make it lipid-soluble. Valinomycin was the first ionophore to be recognised, isolated in 1955 by Hans Brockmann and Günter Schmidt-Kastener at Göttingen University. It has 36 atoms in its ring, which is composed of L-lactate and the amino-acid fragments L-valine, D-hydroxyisovalerate and D-valine. It is both chemically and metabolically stable in water. Figure 3 shows two ionophores.

Valinomycin prefers to surround a potassium ion, while monensin is happier with a sodium ion. Molecules like these solved the problem of selectivity and ion mobility, and with their aid the so-called sodium pump could be primed. This is the mechanism by which sodium ions are moved in and out of a membrane. In nerve cells this leads to a flow of electrical impulse along the axon.

Nerve cells are unique in their ability to generate a pseudo-electric current. A charge of electricity can be passed down them, but not in the usual way of electrons flowing down a conductor. Instead they pass a wave of electric potential difference along their length.

At rest the nerve cell membrane is

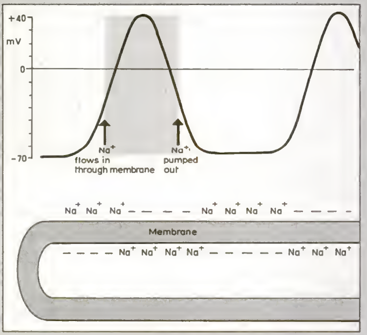

+40
mV
0
-70
Na+ flows in through membrane
Na+ pumped out
Na+ Na+ Na+ — — — — Na+ Na+ Na+ Na+ — — — —
Membrane
— — — — Na+ Na+ Na+ Na+ — — — — — — Na+ Na+ Na+

Figure 4 *How movement of sodium ions across a nerve cell membrane creates a wave of electricity along the neuron*

no connection between salt intake and high blood pressure.

Whatever its origin, our strong liking for salt develops early in life and it is one that is so easy to satisfy. Oddly enough, it may even be a natural rather than an acquired taste. Predominantly meat- or fish-eating societies, such as the Eskimo, dislike salt, probably because they get enough naturally. But most humans use it and we can, possibly, trace our inconsistent attitude towards salt back to an early evolutionary stage when we had to adapt to an aquatic environment (*New Scientist*, 12 April 1984, p 11). Animals, too, have a craving for salt but take just enough to satisfy their need. We overconsume when it is not necessary, but when we lack salt and need it urgently we do not experience a craving for at least a day, and often much longer. Under stress, the body has a mechanism for recycling sodium, so we rarely need to bother about this element in our diet.

We eat a lot of salt because we cannot avoid it. Salt is not simply used as a flavouring agent; it also has beneficial preservative qualities. Salt can prevent or retard the growth of the microorganisms that cause decay, as in cheese, especially blue cheese. The blue veins are a salt-tolerant mould. Salt also prevents butter turning rancid but here, and in margarine, it is added chiefly to enhance the flavour. Not only sodium chloride but sodium nitrite, sodium nitrate and sodium polyphosphates are used to preserve processed and tinned meats.

One of the major routes of salt into our bodies is in cereal permeable to potassium ions but impermeable to sodium. Nor will it allow negative ions to penetrate. The concentration of K^+ is higher on the inside, while Na^+ is even higher on the outside, and there is a net potential difference of −70 millivolts (mV) across the membrane (Figure 4). When the nerve cell is activated it opens channels to allow Na^+-ionophores to move through the membrane, and more Na^+ actually flows in than required to balance the charge. This causes a sudden reversal of potential difference, but the effect is only temporary because the sodium ions are quickly pumped out again. The energy for this process comes from the body's stores made up of ATP (adenosine triphosphate).

Exactly which ionophores are used in this process remains uncertain. Nevertheless, the idea that certain large molecules could surround sodium and potassium ions, and make them soluble in organic solvents, was sufficiently revolutionary to attract the attention of inorganic chemists. They set about investigating other molecules that could do the same trick.

The most useful of the synthetic ionophores are the crown ethers. Charles Pedersen of the Du Pont chemical company synthesised about 50 of these in the late 1960s. The best known are shown in Figure 3. So useful have these become that they are now to be found in most chemical research laboratories. The addition of a crown ether to a reaction can have a catalytic effect if that reaction involves sodium or potassium salts. Indeed, a whole host of inorganic salts of the alkali and alkaline-earth metals groups can be made to do remarkable things when crown ethers and other inorganic ionophores are present. A whole area of host-guest chemistry has blossomed as a result of the discovery that large molecules (hosts) can entrap smaller molecules or ions (guests) and cause them to undergo unexpected reactions.

Until this year the crown ether ionophores were unable to distinguish Na^+ from K^+ and could not carry one of these across a membrane without the other. Now Tsunehiko Kuwamura and colleagues at the chemistry department of Gunma University, Japan have discovered how to achieve such separations by adding a long-chain fatty acid to the system (*Chemistry Letters*, 1984, p 607). They report that either Na^+ or K^+ can be moved through an organic membrane of chloroform depending upon the choice of fatty acid. Thus in the presence of the 18-crown-6 ionophore and stearic acid, potassium ions were transported across the membrane, but sodium ions were left behind.

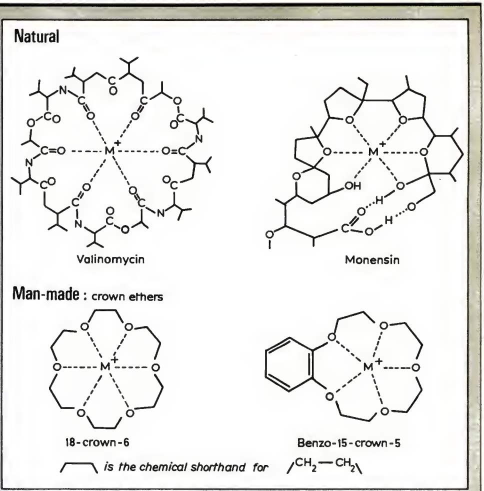


Figure 3 *Natural and man-made ionophores (M^+ represents a metal ion such as Na^+)*

A more dramatic development has been the identification of antibodies by a crown ether and PVC membrane. Garry Rechnitz of the University of Delaware in the US has reported a modified ion electrode that could register the presence of antibodies to the cardiac drug digoxin (*Analytical Chemistry*, 1984, vol 56, p 801). The electrode has a membrane of PVC incorporating the crown ether benzo-15-crown-5 chemically bonded to digoxin. This recognises the antibody, resulting in a change of electrical potential across the membrane. On its own the membrane is capable of doing this, via the K^+-ionophores. But attachment of the antibody to the modified crown ether increases these potential differences, and changes of 20 mV were recorded. The system is capable of detecting antibodies at the level of parts per billion, and it could lead to a revolution in techniques of diagnosis.

Slowly the secrets of sodium in the body are being uncovered and chemists are extending their knowledge and use of this common element. Sodium chloride still remains one of the staple feedstocks of the chemical industry, ending up as such diverse materials as paraquat, PVC, and aerosol propellants. In Britain most salt is mined (from the enormous salt deposits beneath Cheshire and Lancashire) by pumping in water and pumping out brine. But rocksalt mining has undergone a revival to meet the demand for the 1·5 million tonnes used each year in clearing Britain's icy roads. The piles of dirty red brown salt at the sides of our roads represent our growing dependence on salt. And the red-brown colour? This is sand blown from off the red desert that was Europe in the times when the ancient sea that covered Britain was drying out and crystallising as salt. □

foods, especially bread, breakfast cereals and biscuits. An ordinary 800-gram loaf contains four grams of salt, without which we would find its taste very odd.

The average daily salt-intake of 10 grams in Britain is made up as shown in Figure 1, p 29. This shows that we could get by on only natural sources for our essential daily three grammes. Just how we change the sodium content of food is illustrated in the Table overleaf. The ratio of sodium to potassium, Na/K, is less than one in most foods before processing, but is greatly altered in favour of sodium before we eat them.

High blood pressure is an important contributory factor in heart disease, strokes and kidney malfunction. Controlling blood pressure is advocated by medical authorities as a means of preventing these conditions, and one way of doing this is to reduce salt intake. Some people seem to be especially prone to high blood pressure, and for them a low-sodium diet is advocated. This can be achieved simply by reducing sodium chloride intake or by using a salt substitute such as potassium chloride. Consequently, salt formulations of 50 per cent potassium chloride or even pure potassium chloride are now on sale in supermarkets at ridiculous prices—up to ten times the price of common salt.

Individuals can reduce their salt intake by throwing away their salt cellars and not buying any more salt, even for cooking vegetables. If this seems too drastic, then cutting out high salt foods such as bacon, bread and cheese will help,

A CHRISTMAS LETTER

Dear War on Want,
I realise that for millions in the Third World Christmas is just another day in the long struggle against poverty, hunger and disease.

I also know that you are working successfully with men and women in many countries – Bangladesh, India, Ethiopia, Angola, Nicaragua, El Salvador and many more – helping them to stem the tide of suffering.

Please accept the enclosed Christmas donation of:
£50 ☐ £30 ☐ £10 ☐ £ ____ towards your valuable work***
Please tick for receipt ☐
Signed ____________
Name ____________
Address ____________
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____

Please send to: War on Want,
Room 96, Freepost, 467 Caledonian
Road, London N7 9BE (no stamp needed)
Standing order details on request ☐
***Access/Visa holders
may telephone in their
donations on
01-609 0211 ext. 10

WAGE WAR ON WANT

Sodium (Na) and potassium (K) levels in common foods

Food	Sodium*	Potassium*	Na/K ratio
Flour	2	140	0·01
Bread	540	100	5·40
Milk	50	140	0·36
Cheese	610	120	5·08
Pork	63	274	0·23
Bacon	1480	233	6·35
Potatoes	7	570	0·01
Crisps	550	1190	0·46
Vegetable Oil	<1	<1	—
Margarine	800	5	160·0
Eggs	137	136	1·01

*Units are mg per 100 g

together with a shift toward unsalted butter or margarine. A really rigorous low-salt diet may be prescribed, such as the Kempner rice diet: boiled (unsalted) rice has only one-fiftieth of a gram of salt per kilogram and a Na/K ratio of only 0·05. This diet can reduce high blood pressure without weight loss.

But is salt the real culprit? In his weighty tome on *The Hunger for Salt* (Springer Verlag 1983, and reviewed by *New Scientist*, 23 June 1983, p 883), Derek Denton concludes that salt may be to blame but that there is no proof that it raises the blood pressure in most people, although in a few salt sensitive individuals it might. More recent statistical research seems to give salt a clean bill of health.

David McCarron and co-workers at the Oregon Health Sciences University and John Stanton of Temple University, both in the US, analysed the diet and blood pressures of 10 372 representative Americans. In their research paper, (*Science*, 1984, vol 224, p 1392), they conclude that salt is not a factor of high blood pressure but that low levels of the nutrients calcium, potassium, vitamin A and vitamin C are. If anything the group of people with the highest blood pressure took in *less* sodium than the rest. These were all normal healthy people who showed no signs of high blood pressure before taking part in the test. It led to McCarron and his co-workers proposing that the high-risk group should take in more calcium, potassium, vitamin A and C; and this, they rather capriciously suggested, could best be done by eating more dairy foods such as butter, cheese, cream and milk! In the process, it would also correct the low salt level.

Of the four current medical health fads—salt, animal fats, sugar and fibre—McCarron's paper appears to overturn accepted dogma concerning the first two. Of course, this type of statistical analysis *proves* nothing and is of no benefit to the individual. However, it may salve the consciences of those who lack the willpower to stick to a diet.

Dr John Brown of Britain's Health Education Council has rightly warned that it is probably the *balance* of minerals in our diet that is the key rather than one particular essential element. Because our salt intake is so grossly in excess of our needs, he argues that this is where we should begin to correct things. He may be right, but for the wrong reasons. It might not be the sodium which is the problem, but the chloride.

Recent work on rats has shown that it is the chloride content of salt which pushes up their blood pressure. Theodore Kurtz and Curtis Morris of the University of California at San Francisco reported in *Science* last year (1983, vol 222, p 1139) that, whereas sodium chloride increased blood pressure, sodium hydrogen carbonate and sodium ascorbate did not. These results were not due to changes in weight, potassium intake or any other aspect of the diet, which were all carefully controlled. The authors concluded that chloride might be the culprit because at high levels it can lead to loss of calcium from the body.

The plot thickens, but without adequate sodium our bodies lose weight, suffer general weakness, and muscular cramps. The fact remains that sodium is essential. ☐

Dr John Emsley is reader in inorganic chemistry, King's College, London.

CHRISTMAS BOOKS

Painted ladies and common footmen

Colour Identification Guide to Butterflies of the British Isles
by T. G. Howarth, *Viking, pp 151, £14·95*
Colour Identification Guide to Moths of the British Isles
by Bernard Skinner, *Viking, pp 267, £20*
Atlas of Butterflies in Britain and Ireland
by J. Heath, E. Pollard and J. A. Thomas, *Viking, pp 158, £17·95*

Ashley C. Morton

VIKING is the new hardback name of Penguin Books, which has the reputation of being very astute commercially. I am surprised, however, that a market exists for yet more identification guides to British butterflies unless they follow the recent trend away from the almost philatelic collection of specimens and towards the study of butterflies in their natural habitats. The *Colour Identification Guide to Butterflies of the British Isles* makes an attractive and well produced table decoration, but illustrations of mounted specimens are of limited value to modern naturalists, particularly when—as in this case—critical features are not depicted clearly.

Although the guide includes an identification key, progress passed the first dichotomy (which demands rather close inspection of the head of the insect) will prove difficult for the novice lepidopterist lacking a dead specimen to examine.

The numerous illustrations of rare aberrations would be a welcome feature in a book on variation, but their inclusion here is more likely to confound than assist identification. The text is uninspired, and the notes on food plants, distribution and abundance are frequently incorrect. To be brutal, the only worthwhile feature of this book is the collection of plates of the immature stages, copied by R. B. Davis from the originals of F. W. Frohawk. Such clear and accurate illustrations are generally a more useful aid to identification than are colour photographs.

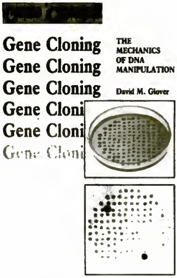
Far fewer books are designed to help the naturalist pursue an interest in moths, and so the *Colour Identification Guide to Moths of the British Isles* deserves more generous treatment. Again, the photographs are of mounted specimens, but in this instance it is excusable as most readers will be attempting to identify captured specimens. An excellent feature is the inclusion of drawings which direct attention to fine differences between similar species. The text gives brief but generally accurate notes on the biology of each species. Indeed, my only reservation about this book concerns Skinner's decision to exclude figures of the genitalia; I am not sure that a number of species can be confidently identified without such detailed examination. I hope this useful book will encourage more naturalists to study such an important group of insects.

Forty years ago, Professor E. B. Ford gave us one of the best books about butterflies ever written (*Butterflies*, Collins, 1945). Commercial success may not follow academic excellence, but Viking should congratulate itself on publishing the *Atlas of Butterflies in Britain and Ireland*, which promises to be as influential as that classic *Butterflies.* The atlas is based on a set of "dot maps", one for each resident species. These are the fruits of a national recording scheme, organised by John Heath, which is the envy of butterfly ecologists throughout the world. Although recent advances in computer graphic techniques would permit more detailed presentation of the available data, the maps dramatically confirm that many of our butterfly species have seriously contracted their range since 1940, especially in eastern England.

Splendid monochrome drawings depicting the adult butterflies in their natural positions, accompany the maps; and two of Britain's leading specialists describe the ecology of each species in remarkable detail, despite the limited space available. By restricting their accounts to original observations, Pollard and Thomas have broken the tradition—all too typical of popular butterfly books—of perpetuating errors. As a result they have provided the most accurate and up-to-date account of the ecology of British butterflies currently available, together with an extensive bibliography.

The authors devote the final chapter to an interpretation of the patterns of change, and examine factors influencing the distribution and abundance of butterflies. This section should be required reading for conservationists, planners, and land owners. Although the increasing scarcity of many butterflies can undoubtedly be attributed mainly to habitat lost as a consequence of changes in agricultural and forestry practices, populations of rare butterflies also have an appalling history of survival on nature reserves.

Too many extinctions have been due to a failure by conservationists to maintain suitable breeding habitats, largely through ignorance of the ecological requirements. This book should help to avoid repetition of these mistakes, but it also emphasises how much more we still need to know about our butterflies. Perhaps the atlas's greatest value is that, like Ford's *Butterflies*, it gently steers the reader towards careful field studies and away from the silly nomenclatural exercises that so often masquerade as "science" in the lepidopterological literature. □



Gene Cloning

The mechanics of DNA manipulation

D M Glover, Department of Biochemistry, Imperial College, London

This book gives a comprehensive account of the techniques for constructing recombinant DNA molecules *in vitro*. After describing the general principles for cloning DNA, the book goes on to cover recombination and mutagenesis of DNA *in vitro;* bacteriophage vectors and bacterial plasmid vectors; expression of cloned DNAs in *E.coli* plasmids; the physical characterisation of cloned DNA segments and their counterparts within chromosomes; gene cloning in fungi and plants and expression of cloned genes in animal cells.

December 1984 222 pp illus
Hb 0 412 26600 8 £15.00
Pb 0 412 25430 1 £7.95

Lasers in Medicine

An introductory guide for the non-specialist

G T Absten and **S N Joffe** both at the University of Cincinnati Medical Center

This introductory guide to lasers in medicine, describes what lasers are, how they work, and what they can do for the patient. The book uses a minimum of technical language, and has many clear and simple diagrams. There are also several colour photographs showing the effects of laser treatment.

December 1984 80 pp illus
Pb 0 412 26650 4 £4.95 Ex USA

Seventh Edition

Selective Toxicity

The physico-chemical basis of therapy

A Albert, Emeritus Professor, Department of Chemistry, Australian National University

This distinguished and popular book, now in its 7th edition, describes the way in which drugs, agricultural agents, and other chemical substances work at the molecular level; particularly how they are able to select certain target cells without harming others.

7th edn. January 1984 c. 700 pp
Hb 0 412 26010 7 £40.00
SP 0 412 26020 4 £19.75

Eighth Edition

Insect Physiology

V B Wigglesworth, Professor of Zoology, University of Cambridge

This established text provides an introductory account of the physiology of insects intelligible to any reader with an elementary knowledge of biology. The approach in this edition remains unchanged, but accounts of the more important recent advances are included and many more illustrations have been added (some 50 text figures and three plates) which serve to lighten the text.

8th edn. November 1984 200 pp illus
Hb 0 412 26460 9 £15.00
Pb 0 412 25900 1 £7.95

Field Guide to Soils and the Environment

Applications of soil surveys

Environmental Resource Management

G W Olson, Associate Professor of Soil Science in Resource Development, Cornell University

This workbook is designed to accompany the textbook *Soils and the Environment* and will lead the reader into field studies, laboratory work, and cartographic manipulations. The book addresses itself to all those involved in teaching, or learning about soil surveys. Thus it will be used by university students, professors, and employees of government and private agencies interested in land resources.

December 1984 219 pp illus
Hb 0 412 25960 5 £25.00
Pb 0 412 25970 2 £12.95

Elements of Simulation

B J T Morgan, School of Mathematical Studies, University of Kent at Canterbury

This book covers all aspects of simulation, from the generation and testing of pseudo-random numbers through to their use in a variety of applications. Many exercises are provided, some with worked solutions, and the algorithms and techniques are illustrated by a number of computer programs written in BASIC.

October 1984 352 pp illus
Hb 0 412 24580 9 £27.50
SP 0 412 24590 6 £12.95

Electron Beam Analysis of Materials

M H Loretto, Professor of Materials Science, Birmingham University

This book explains the many electron beam techniques developed for assisting the microstructure of materials. The techniques covered include: transmission electron microscopy, scanning electron microscopy, conventional and convergent beam electron diffraction, Auger electron spectroscopy, electron probe microanalysis of bulk samples and X-ray microanalysis of electron transparent samples.

November 1984 210 pp illus
Hb 0 412 23390 8 £22.50
Pb 0 412 23400 9 £10.50

Encyclopeadic Dictionary of Industrial technology

Materials, process and equipment

D F Tver, Lecturer in technical and business fields
and **R W Bolz,** Association of Consulting Automation Engineers

This seminal reference work is the most comprehensive of its kind and will prove invaluable to working professionals and students. Many manufacturing processes involved in the conversion of raw material to finished products are described, with a detailed review of materials and their uses. The book is unique in that it relates to the whole general manufacturing field and interrelates the processes.

October 1984 400 illus
Hb 0 412 00501 8 £25.00

Chapman and Hall

11 New Fetter Lane, London EC4P 4EE

A new space odyssey

Entering Space: An Astronaut's Odyssey
by Joseph P. Allen, *Orbis, pp 223, £15*
Conquest
by David Baker, *Windward, pp 192, £9·95*

Mat Irvine

JOE ALLEN is a relatively recent recruit to the astronaut corps, but he has produced one of the best popular accounts of just what it means to be a space traveller.

Allen does not restrict himself to those missions he knows most about. Rather he describes a shuttle astronaut's viewpoint in general, linked into NASA's overall grand plan. Allen's text, written in conjunction with Russell Martin, includes the sort of anecdotes that devoted astronautical followers delight in. He reveals that "mission planners for the three Skylab flights did intend to include a stock of table wine for the crew's enjoyment, but the Women's Christian Temperance Union objected and NASA, always mindful of its public image scuttled the plan."

Intriguing as Allen's text is, the photographs overshadow it. Over half the book is taken up with excellently produced full colour photographs. And if you are expecting the usual NASA handouts, there is a pleasant surprise in store. Many of the photographs have not been published before—and although a shuttle launch looks spectacular from any viewpoint, it is good to see a different one occasionally!

Most of the book revolves around the shuttle. But one chapter does venture further. Here Allen attempts to cover Apollo, Viking and Voyager all in one, and in many ways this does not work. The photographs are as good as those in the rest of the book, but the chapter does not fit into the overall plan.

Shuttle astronauts make new conquests

David Baker has yet to go into space. But he is a world authority on the subject, a NASA consultant, and the author of many books. His latest book, *Conquest*, is summed up by its subtitle: "A history of space achievements from science fiction to the shuttle". "Histories" come in all shapes and sizes, and in a book of only 192 pages, this one is necessarily limited. But Baker does manage to cram in a great deal of information.

Baker begins with a brief mention of the early science fiction writers—Lucian, Francis Godwin and the first sci-fi film of George Méliès. He goes on to draw attention to the early astronautical pioneers, Tsiolkovsky, Goddard and von Braun. He takes the reader through the early research, the flights of captured V-2 rockets, the X-15, the first satellites and the first manned flights of Vostok and Mercury, and ends with the hastly conceived flight of Vostok 2. This last was probably Nikita Khrushchev's answer to the announcement that "America would have a man on the Moon by the end of the decade", which of course it did.

Baker describes progress from the Gemini flights which tested most of the procedures that would later be used by Apollo, through the tragedy of Apollo 1 and on to Apollo 11, and that landing on the Moon. He continues with the final Apollo flights, the Soviet efforts in unmanned lunar exploration, unmanned Earth satellites and probes to the planets. And he includes artists' impressions of new satellites and probes such as Olympus, Galileo and Giotto; space stations such as Soyuz 4 and 5, and Skylab; the Apollo-Soyuz Test Project and the saga of the Salyuts.

The final chapter is mainly taken up with the shuttle. And, towards the end, Baker mentions future plans, from large space structures to powersats and space colonies.

Overall, *Conquest* is a reasonably balanced book. The Americans and NASA get a larger percentage of the illustrations, but then they do make them more available. The Soviet side of space exploration is not ignored, but the European Space Agency does not get many mentions. Unfortunately, the photographic reproduction does not compare with *Entering Space*, but then it would be difficult to reach that high standard.

Both books would make excellent presents. *Conquest* would be ideal for an astronautically-minded niece or nephew, but I think I would like to keep *Entering Space* for myself. ☐

Pop-ups and psychopop

The Facts of Life
by Jonathan Miller and David Pelham, *Jonathan Cape, pp 12, £8·95*
The Living Body
by Karl Sabbagh with Christiaan Barnard, *Macdonald, pp 223, £9·95*

Richard Smith

ONE OF the most important developments in my medical education took place when I was watching *The Generation Game*. The competitors were trying to fit various organs into an outline of the body, and most had no idea where anything went—not even the lungs.

That lesson taught me that I couldn't assume too much when trying to explain to patients what had gone wrong with their bodies. If patients knew more about their bodies, then their communication with doctors (which surveys consistently show to be a main complaint of patients) might be much improved. Doctors and patients will gain from the publication of books like *The Facts of Life* and *The Living Body*.

I am sure that the authors had much grander and less altruistic aims, but Sabbagh does spill over into the overtly health-orientated. For example, he advises pregnant women that "staying active is one of the most important things that a mother-to-be can do".

Both books have an ostentation that makes them more like travel brochures than biology textbooks. Miller and Pelham achieve this in their "remarkable book" by their "breathtaking three-dimensional illustrations" as the blurb on the back breathlessly tells us. And a similar breathless tone is kept up inside. The text is littered with similes to the point where they become laughable. On the first two pages alone "relay races," "train tunnels," "spiral staircases," "the words of a sentence," "and zip fasteners" are all invoked.

But then the words are not the point of this book: it is the pop-up pictures that matter—even to the extent that some of the text is virtually hidden. The pop-ups are beautiful. But I was disappointed as I went through the six of them that a penis didn't point straight up at me (there is a penis but it discreetly points downwards). Sadly, too, I don't think that the pop-ups provide much more information than two-dimensional drawings: they are just gimmicks.

What Sabbagh's book lacks in pop-ups, it makes up for in pretty pictures. But too many of these are irrelevant; for example, the chapter on "coming together" contains three pictures of naked couples that must bump up the price without adding to the substance. The idea of describing the body in terms of everyday actions rather than systems was a good one. But Sabbagh is at his strongest when describing something mechanical, such as how joints work, and at his weakest when straying off the strictly biological into subjects such as "the mysterious phenomenon of love". Sometimes the switch from this psychopop to the biologically particular jars too much: "The force of attraction between male and female makes the world go round, and the process of sex inheritance ensures that there are roughly the same number of men and women in the population".

The Living Body looks beautiful and reads clearly, but I found it curiously unsatisfying. I felt that something was missing, and when I watched one of the programmes in the television series on which it is based I realised what. This is the book of the film, and once you take out the rock music and turn the moving film to a few still photos, most of the excitement is gone. Both of these books suffer from the words following, not leading: in the best books the words come first. ☐

The riddle of the Sphinx

Psychological Games
by Nicola De Carlo, *Macdonald, pp 183, £12·95*

David Cohen

Camera Press

PEOPLE love games. The riddle of the Sphinx shows that even the Greeks had quizzes and, no doubt, some archaeologists will eventually find that Aristotle invented bingo. If Oedipus had had a properly creative mind, he would have been less baffled by the Sphinx and realised that the crisis called for a spot of lateral thinking. It had to hinge on what was meant by *legs*. If he had imagined the different forms of legs around, he might have soon seen that is was men (and women) that crawled on four, walked on two and then had to use a stick. Not being a member of MENSA, he got what he deserved.

In this sometimes engaging book, De Carlo gives a very potted summary of some theories of testing and then goes on to seduce the reader with lots of interesting questions. I had better own up here that most tests intimidate me. When I was a teenager, I went through a phase of doing *The Times* crossword puzzle. Days when I got four clues right were brilliant days. Despite this reluctance to do tests, I felt *New Scientist* readers would be cheated if I did not test these tests for them.

Some of De Carlo's questions are far more tests of knowledge and vocabulary than of pure intelligence, whatever that may be. Knowing which of these words mean the same—defence, conservation, decision, protection and operation—proves more about your vocabulary than about your intellect. De Carlo has a nice line in squashed squiggles like this and asking what it will look life if (i) distorted or (ii) flipped and rotated. Sometimes, I must say, I thought De Carlo got the answers wrong.

Psychological Games brings together tests of intelligence, creativity, aptitude and personality. Plunging into testing myself, I discovered that I was not bad at words and maths, but pretty abominable at anything mechanical. Questions requiring one to judge what a cog did to a wheel, a wheel to a cog, a cog to a balance, or a set of balls to anything else left me baffled, and the objects concerned in a twist. On the whole, as an instant sketch of my abilities, it was not too inaccurate.

Occasionally, De Carlo hints at some research that suggests games of this sort might not be totally infallible. Usually, though, the text does not admit that these are only games, not gospels leading to total insight. This faith in tests is at its worst in the personality section. De Carlo brings together a number of different tests to arrive at 210 questions. Answer yes, no, or maybe to them, and you will discover the full reality of how anxious, obsessive, autonomous, happy, guilty, hypochondriacal, stable, depressed and neurotic you are. I think there were a few additional traits measured by the 210 questions but, being an unstable extrovert, I got bored with cataloguing all of them. The personality section is rather a hodgepodge.

Another slight difficulty with this book is that it is hard to share. One of the IQ tests takes 30 minutes. What is everyone else meant to do while you concentrate for half an hour on the sums and squiggles? It is a pity because the most fun one could get out of this book would come from doing the puzzles in a group, competitively or cooperatively (depending on personality type). The format as a conventional book makes that difficult. As a serious book, it is not serious enough; as a collection of party games, it does not quite work. But then I am probably writing in an obsessive neurotic mood. ☐

Windfuckers and pettychaps

The Oxford Book of British Bird Names
by W. B. Lockwood, *Oxford UP, pp 174, £7·95*

Desmond Hawkins

GERARD Manley Hopkins's poem "The Windhover" might not present itself quite so endearingly had he chosen to call it "The Windfucker", although the meaning would be unchanged. Before the word *fuck* began its descent into outlawed vernacular, it had had an earlier meaning, to beat or strike. In the Middle Ages it was the *mot juste* for the rhythmical strokes of the kestrel's wings as it rides the wind, poised and stationary.

This odd scrap of information is one of a host of similar insights that emerge from Professor Lockwood's examination of the names we have given, at one time or another, to the birds that come our way. The more conspicuous and familiar species have traditional names stretching back into antiquity. Others, seen only rarely or imprecisely, remained anonymous until scientific ornithologists undertook to coin names for them. The goose bears the most venerable name, dating back at least to 3000 BC. The roseate tern had to wait until 1813 to be given an English name, by George Montagu.

In his foreword, Lockwood claims justly that "the elucidation of bird names is as much an art in its own right as any other branch of linguistics, one which necessarily calls for specialist philological training". In an area of ornithology that has remained largely amateurish it is a pleasure to see the finely-tempered scalpel of a scientific discipline cutting away the misleading accretions of old wives' tales and hopeful guesswork: there is a bracing confidence in such remarks as "a word of this shape cannot be very old".

The truly primitive names illustrate the extent to which our ancestors identified birds by the sounds they made or by some one unusual visual feature. A high proportion of names have corrupted an original onomatopoeic word that echoed a song or call—as "pettychaps" mimics the garden warbler. "Lapwing" is shown to be unconnected with the bird's flight but traceable to its crest, which was evidently its definitive attribute in the eyes of our invading Saxon forebears.

In all, the book includes some 1500 names in dictionary form. As knowledge for its own sake it is rewarding, but it also has important secondary applications. For example, the fact that a bird as rare today as the golden oriole had a medieval vernacular name in Britain is striking evidence that this species must then have been relatively common. Conversely, why did the tufted duck, so common today, have no traditional name before 1678, when John Ray gave it one?

British bird names, like the birds themselves, have been known to migrate. The American colonists took some with them, and their separate histories might have been worth a little more attention. Kinglet, gallinule and brant are three which have proved more durable than their narrowly British record suggests. In the opposite direction only one American coinage seems to have displaced a traditionally British name—the absurd oystercatcher, invented in Carolina in 1731. ☐

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What to do if the star bug bites

Atlas of the Night Sky
by Storm Dunlop and Wil Tirion, *Newnes, pp 80, £4·95*
1985 Yearbook of Astronomy
by Patrick Moore, *Sidgwick & Jackson, pp 216, £5·95 pbk*
Patrick Moore's Armchair Astronomy
by Patrick Moore, *Patrick Stephens, pp 185, £9·95*

Tony Jones

NOW THAT long evenings are with us again, why not take advantage of the crisp dark skies to get acquainted with the stars? These three complementary books will get you off to a good start, whatever the weather.

You will need a set of star maps, and the new *Atlas of the Night Sky* represents excellent value. The nugget in this book is Wil Tirion's set of charts showing all the stars in the sky down to magnitude six (practically all those visible to the unaided eye). Tirion, a Dutch graphic artist, is better known for his more detailed *Sky Atlas 2000.0*, which has rapidly set a new standard in celestial cartography. These new maps have the same neat, uncluttered appearance, and cover the whole sky in ten 18 by 30 centimetre charts. Stars are shown as black dots on a white background, and there are special symbols for double stars, variable stars, assorted nebulae and clusters, and galaxies. Constellation boundaries, the ecliptic and galactic equators are marked, and the Milky Way is shown in pale blue. Like its big brother, this atlas is plotted on coordinates adjusted to the year 2000 (the new international standard replacing 1950), and so will become even more useful as the years go by. Sadly, the professional quality of the maps is not reflected in the printing. The ink can be rubbed off easily with a soft eraser, which will disappoint observers who need to plot positions on the charts in pencil.

These maps are a serious challenge to the long-established *Norton's Star Atlas*, but I think *Norton's* still has the edge for its distinctive style and durable ink.

Most of the book, which is edited by Storm Dunlop, secretary of the British Astronomical Association, is a detailed guide to each of the 88 constellations. This will be most suitable for beginners finding their way around the sky. A potted course in astronomy, covering celestial coordinates, stars, nebulae, galaxies, the Sun, Moon, planets and much else, complete the book most attractively.

To follow the comings and goings in the sky, you will need something more than the *Atlas*, and what better guide to the changing skies than Patrick Moore's *1985 Yearbook of Astronomy*? Monthly star charts show the constellations visible from the latitudes of Britain and Australia, and there is the usual month-by-month commentary on what to look out for. In February, for example, Venus will be bright

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Regiments of herons

The Herons Handbook
by James Hancock and James Kushlan, *Croom Helm, pp 288, £16·95*
The Birds of the Wetlands
by James Hancock, *Croom Helm, pp 152, £13·95*

Stephen Mills

TIMES HAVE CHANGED. When James Hancock produced the "original" *Herons of the World* with Hugh Elliott in 1978, they had to offer it as something of a specialist, luxury volume. Now, just six years later, the market is ready for an economy model, a small handbook describing and illustrating all 60 species of the world's herons, egrets and bitterns. The detailed text is quite outside the usual tick-and-turn-over field-guide class. It deals with population and distribution puzzles, analyses feeding and breeding behaviour, and even looks at taxonomy. For example, the authors explain at length why, on the basis of their own observations of interbreeding, they have "lumped" the so-called western reef heron and the dimorphic heron within the little egret species; they justify the assumption that the five-foot tall goliath heron is sedentary by reference to 21 birds that were ringed and controlled in the Transvaal in 1975; and rather than give a general description of the rarely observed, cryptically-coloured South American zigzag heron, they quote an actual observation of the bird made on 8 August 1979. (It "had a 'peculiar tail-flicking action': from a 'neutral' position downwards and to one side, back to neutral, down to the other side, then back to neutral; each action within this movement occurred once every second . . .".)

It is a measure of the increasing sophistication of birdwatchers that they really do want this sort of data. One reason is that people are travelling more, and world distribution maps, like the ones provided here, are very useful for identifying strange herons in strange places. But a book of this kind has an additional value in that it breaks down false geographical barriers. It helps amateurs to realise, for example, that their "British" bittern is not enough to cast shadows. Will you be the first person ever to photograph a Venusian shadow? In the autumn, Halley's long-awaited comet will be visible at last in small telescopes.

Moore rounds off the book with a crop of specialist articles by distinguished writers. This year there are pieces on infrared astronomy, Halley's comet, the Sun's atmosphere, active galaxies, southern variable stars and the Very Large Array of radio telescopes in the United States. If the star bug has really grabbed you, the list of 130 astronomical societies should help you find fellow sufferers in your own area.

Finally, what do budding astronomers do when the clouds roll in? They could do worse than retire to an armchair with *Armchair Astronomy*, another new book from Patrick Moore. This anthology of 126 entertaining articles is made to be dipped in and out of, rather than read in one sitting. The pieces cover everything from the Moon illusion to "comet wine", and are all written with Moore's characterisitic energy and ready humour.

Any one of these fine books would make a good present for a proto-astronomer, young or old. ☐

Mathematical diversions

Mathematical Byways in Ayling, Beeling and Ceiling
by Hugh ApSimon, *Oxford UP, pp 97, £5·95*

Stephen Ainley

MATHEMATICS is fun. And this delightful and unusual problem-book illustrates the point. It covers a dozen topics, each starting with one or more specific problems, neatly and naturally framed in terms of the three villages and their remarkable inhabitants. Then we get, not just the answer, but a solution worked out in general terms and then applied to the specific cases. Next comes a discussion of the "composer's problem"—how to create an appetising problem-morsel out of the general solution. And, finally, an "extension"—further questions suggested by the general solution and left to the reader.

The topics range widely. Some are quite new: for example wrapping parcels with a minimum-sized sheet of paper, and a counterfeit coin-weighing problem (quite different from those well-known 12 coins) whose novel fascinations keep side-tracking me from my task of writing this review. And readers who have met some topics before—such as ladders crossed in an alley, or a journey for three on foot/bicycle/scooter—are likely to get fresh illumination from the solution discussions.

No maths beyond O-level is needed; ingenuity and a bit of care count for more than techniques.

ApSimon displays most admirably the difficult art of presenting accurate arguments and proofs in clear and simple language. The discussions are a pleasure to read, with no unnecessary jargon and no parade of rigour, and they repay re-reading too.

That this book launches a new Oxford University Press "Recreations in Mathematics" series is very welcome news, for these past few years have been particularly lean ones for fanciers of mathematical problem books. Meanwhile, if you are one of them, this is the book to give yourself this Christmas. ☐

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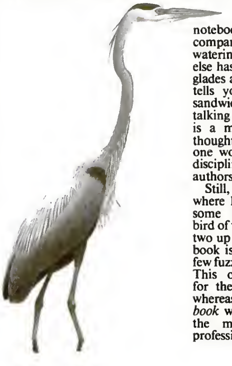
just a bird of the Suffolk reed beds. It breeds from Russia, through China to Japan, and its conservation must be planned in that context.

Detail, of course, is not always absolutely informative. If you wanted to plan your package holiday around what the authors tell us about the nesting habits of the squacco heron you might come unstuck. "The nest has been reported as being built by the male in one to three days (Brown *et al.* 1982), or by the female in six to eight days (Cramp & Simmons 1977), or by both birds (Voisin 1980)."

Nevertheless, no ornithologist could fail to appreciate the regiments of white herons that Robert Gillmor has painted, four pages of them showing 60 plumages scrupulously recorded by the authors. No fewer than 11 herons are white at some stage of their lives. Birds such as the snowy egret or Swinhoe's egret are white all the time; some, such as the little egret, have white morphs; the cattle egret is white except when breeding; the Malagasy pond heron is white only when breeding; and the little blue heron is white in its first year. The only way of distinguishing some of them is by the colour of the tops of their legs or the bases of their beaks, so these illustrations, which were not included in *Herons of the World*, are extremely useful.

The other plates, by Gillmor and Peter Hayman, are reprinted from the earlier volume. Some, like Gillmor's little green heron, are exquisite, although I found some of his egrets a bit short of leg.

Naturally, I have a few niggling complaints: the breeding maps for the squacco heron might have included North-East Spain as it breeds up on the Ebro Delta, and I have found a nest of the little blue heron in California, several hundred miles north of its given range. It was also a little ominous to find that the British Isles was almost entirely obliterated by the binding from the range of the grey heron, especially as Hancock and Kushlan warn us that our 4000 nesting pairs of this species may be threatened by a new breed of irate fish farmers.



The Birds of the Wetlands is a nature notebook, meandering in the company of great men around watering holes where everyone else has been, such as the Everglades and the Coto Donana. It tells you where to buy your sandwiches, and usually ends up talking about herons. Hancock is a much-travelled and very thoughtful ornithologist, but one wonders if he needed the discipline of one of his co-authors here.

Still, he also goes to China where he photographs a handsome Siberian rubythroat (a bird of the woodlands!), which is two up on most people, and the book is attractive if you skip a few fuzzy pictures of phalaropes. This one, then, is probably for the compulsive purchaser, whereas *The Herons Handbook* will probably tempt even the most pennypinching of professionals. ☐

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This work will eventually provide a definitive list of all West African Plants known to be used by man. Vol. 1 covers families A–D; each plant is fully described, its uses and location given, and bibliographical sources cited. An important reference source for all involved in agriculture, horticulture, medical science, food and plant sciences, etc. Early 1985. 900pp (approx). Hardback, boxed. 0 947643 01 X. £70.00. *Published by the Royal Botanic gardens, Kew.*

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Armchair safari for a winter's night

Last Days in Eden
by Elspeth Huxley and Hugo van Lawick, *Harvill, pp 192, £12·50*

Peter Jewell

IT WAS just over 20 years ago that I first visited Africa. At that time, big game photographers were only just starting to replace big game hunters and nothing like this book existed. But, before I went, I did read Elspeth Huxley's *The Flame Trees of Thika*, and it made a deep and lasting impression. East Africa, where she grew up, was a vast and little-travelled country, teeming with game. Or, as we should now rather say, teeming with wildlife. There, one of the pioneers had described to her "... a promised land, teeming with animals who lacked the fear of man. Herds of Kongoni, he had said, browsed on the sweet green grasses. He had seen wildebeeste and zebra by the thousand, and oribi wandering about wagging their tails, and the loping giraffe, like tigerlilies bending with dignity before a gusty breeze, and the big biscuit-coloured eland with their drooping dewlaps and striped withers, and the red, nimble-footed impala walking in single file. Even the lions excited no alarm unless actually hunting, and were ignored, and sunned themselves peacably." It was the Garden of Eden.

Hugo van Lawick was a latecomer to this paradise. He had missed the time when people lived in, and travelled through, a sea of wildlife. Now the wildlife was confined to refuges in a sea of people. In one of these refuges he settled, to devote his creative and artistic skills to photographing and recording the behaviour of animals, and the beauty of the harmony between them and their environment. He set his camp at Lake Ndutu in the Ngorongoro conservation area of Masailand, next to Tanzania's most spectacular national park, the Serengeti.

Last Days in Eden is a biographical account of van Lawick's work, written with Huxley's insight into the ways of African life. They travelled together to the Serengeti, the Gol Mountains, the Oluduvai Gorge, the Ngorongoro Crater and to another famous park, Lake Manyara. The book is illustrated with the best of van Lawick's photographs, and the narrative is so vivid that I felt I was there at the time, crouching behind him as he stalked into position to fire his camera. Nevertheless, it is not just a coffee-table book with a digest of wondrous facts and pictures. It is a distillation from the actual discovery of facts, because van Lawick made many original discoveries about animal behaviour and worked with biologists who pioneered the way to a new understanding of the nature of animals. Indeed, he married one of them, Jane Goodall, and helped to record in photographs and on film her exciting and revealing study of our closest relative, the chimpanzee. This has been one of the most seminal of all studies that have shown the relevance of animal behaviour to the understanding of human nature. Appropriately, the most sympathetic picture in the book is one of Freud, a young male chimpanzee, relaxing with welcoming hand in the afternoon sun.

Van Lawick sets out to record Eden's last days

Van Lawick may have been predisposed to apply these observations to the interpretation of human evolution because he had previously worked with the Leakeys in Olduvai Gorge (the site of their startling discoveries of the fossils of early hominids). I would like to have been with the authors on the afternoon Huxley describes, when they drove in the heat to Mary Leakey's bungalow, and had her show them fossils and the casts of pre-human footprints, three-and-a-half million years old, and listened to her own account of these epoch-making discoveries.

The readers who are quick enough to buy this excellent book, or fortunate enough to receive it as a present this Yule, can make their own choice of the photograph they think most superb. I like the dappled grass-heads that surround a male impala, and the serval in a sea of double-damasked yellow daisies. How close to the ground must van Lawick have been to have captured the shot of the startled and impish dikdik? And who could resist the compelling grandeur of the photograph of a male topi, that pinnacle of evolutionary beauty, standing with deliberate conspicuousness to declare his territory?

My one criticism of the book is of the small size of some of the reproductions. The impact of many of the pictures is lost because they are printed on half a page or less. The stunning photograph of the Serengeti Plains after the rains have created endless and contrasting depths of green, deserves a double page; so, too, do the pictures of migrating wildebeest, and the hunting dogs silhouetted against the twilight.

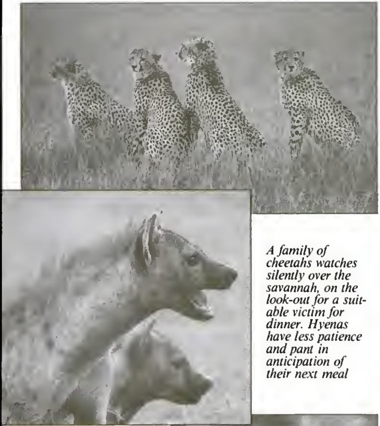
An added joy of *Last Days in Eden* is that Huxley does not confine herself to van Lawick's presentation of Africa. She has her own views about the problems of conservation and the prospects for this relic of Eden. She makes sallies against illegal trading in trophies, corruption in high and low places, the perpetration of "range management" schemes, poaching, the demise of the Serengeti Research Institute, the selfish thoughtlessness of tourists, and against the Masai for their tolerance of flies! Her descriptions of night and dawn, experienced on the floor of Ngorongoro crater, equal the best of her writing in *The Flame Trees of Thika*.

Something of that earlier book is missing, however; the hopefulness and eager optimism of those pioneering days. True, the pioneers greatly accelerated the destruction of the wildlife, and now she cannot but be pessimistic about its future. It is too late to turn back. All the same, I think Elspeth Huxley enjoyed writing this book. She sees the wildlife photographer as a powerful champion of the conservation cause. Between them they also catch the moment, the scene, the incident that may never come again. □

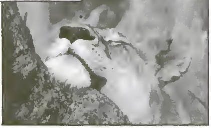
A photographer's year in Eden

Safari: The East African Diaries of a Wildlife Photographer
by Günther Ziesler and Angelika Hofer,
Angus and Robertson, pp 197, £15

Norman Myers



A family of cheetahs watches silently over the savannah, on the look-out for a suitable victim for dinner. Hyenas have less patience and pant in anticipation of their next meal



Unaware of the photographer, a satisfied lioness languishes in a tree, soaking in the early morning sunshine

OF BOOKS on African wildlife, there is no end. Ten years ago they were becoming so-so, with nothing much new to say—while their illustrations were leaving the reader over-killed with ever-more glorious colour and spectacle. So who would have thought that in 1984 we would come across a book that merits more than a moment's notice. On receiving this splendid volume, I spent one hour straight off with it, and I have spent more enjoyable hours since them.

Günther Ziesler's photographs surpass anything I have seen before, including those of Emil Schultes, Elliott Porter and the Bartletts. There are extraordinary action sequences, of a cheetah at full speed, a lion making a kill, and shots of herds silhouetted against the dawn and other "mood" pictures of unusual sensitivity. Far from presenting further zoo-type close-ups, the book depicts African wildlife in its African environment.

Regrettably, we do not learn much of scientific interest from the text. It presents few insights about ecology and behaviour, and still less about conservation. Being a personalised account of a year-long safari, it tells us as much about the writer, Angelika Hofer, as her subjects. This is not to put down the quality of the descriptive writing. If you want a feeling for life on safari, complete with heat and dust, then here you have it. The book bespeaks experience as much as enjoyment.

As a Christmas gift with value to last for many a year of browsing through its pages, this is a fine production. ☐

Wiley

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by **A.J. Ward-Smith,** *Department of Mechanical Engineering, Brunel University, Uxbridge*

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A high flying career

Ascent to Orbit: A Scientific Autobiography
by Arthur C. Clarke, *Wiley, pp 226, £14·95*

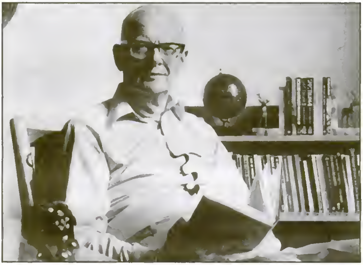
David W. Hughes

THE UNINHIBITED thinker, who can speculate on the future and communicate ideas to the world is a vital ingredient of our advancement. Another is the engineer who shakes the dreams into reality. Arthur C. Clarke is both. His work launched the era of satellite communication and rightly he deserves the title of "the father of the geosynchronous orbit". An Earth satellite orbiting 42 000 kilometres up has a period of 24 hours and thus hovers over one spot on our planet. Clarke has seen this idea transformed from a notion in his 1945 article in *Wireless World*, through the first live transoceanic television broadcast via the Early Bird satellite on 20 August 1964, to this year, 1984, when 1000 million telephone calls will pass through geostationary satellites.

Clarke was born in 1917 at Minehead, Somerset, and went to Huish's Grammar School in Taunton. At 19 years of age he got his first job as a civil servant in the audit department of HM Exchequer. In 1941 he volunteered for the RAF, where he concentrated on radio direction finding and the radar systems used for ground controlled approach. His essay on "The rocket and the future of warfare", written in November 1945, not only won for him the Royal Air Force Quarterly prize but also gave him considerable confidence in his writing ability, and helped him get a grant to attend King's College, London.

By 1948, he had a first class degree in physics and mathematics and he went off to work for the Institution of Electrical Engineers, where he helped produce *Physics Abstracts*. Two years later, with his first book commission and a rising income from part-time writing and radio talks, he left to become a freelance author and has "never been on a payroll since".

Now, 34 years later, with 28 non-fiction and 29 fiction books and an Oscar nomination under his belt, Clarke looks back at his scientific articles. Most of the work included in *Ascent to Orbit* was produced between 1936 and 1950 and appeared in publications such as *Astounding Science Fiction*, *Journal of the British Interplanetary Society*, *Electronic Engineering*, *The Aeroplane* and *Journal of the British Astronomical Association*.


Yorkshire TV

Arthur C. Clarke comes out of orbit for a photocall

Ascent to Orbit reproduces in full, 25 of these papers. Each is prefaced by a short introduction charting Clarke's scientific life and full of chatty details about the jobs he was doing at the time he was thinking about specific scientific ideas. Each paper is given a human face. Too often we know *what* a scientist does but only infrequently are we let into the secret of *why* he moves from topic to topic.

On one level, the book can be regarded as a history of aeronautics. Clarke reminds us that scientific history has seen few technical advances more dramatic than those which, in little more than five years, transformed the rocket from a firework into a machine. He also emphasises the advance of the computer and calculator. Who would have thought that within less than a decade that very symbol of the engineering and scientific trade—the ubiquitous slide rule—would no longer be manufactured? Some of us can even remember using logarithms!

These advances have been essential for the development of satellite communication. But what is also of enormous importance is the work of visionaries like Clarke, who not only have sound scientific ideas but also have the ability and enthusiasm to carry the world with them. His book abounds with the conquest of space, the joy of mathematics and the unquenchable belief that no investment pays better dividends to humanity than scientific research. In true Arthur C. Clarke fashion, there is much more in this book than looking back over one's shoulder to the past. The future is full of hope. We read of the electromagnetic rocket-launching accelerators that could one day grace the Moon, the space elevators that could hang between geostationary satellites and Earth, and the next steps in communication when we all have wrist telephones that can transmit via satellite to recipients worldwide.

Ascent to Orbit is a most enjoyable book; it is beautifully produced and eminently readable. ☐

This week's contributors

Stephen Ainley writes mathematical puzzles and is a regular Enigma contributor.

David Cohen is editor of *Psychology News*.

Richard Gregory is director of the Brain and Perception Laboratory at Bristol University.

Beverly Halstead is a reader in geology at Reading University.

Desmond Hawkins founded the BBC Natural History Unit, Bristol.

Mat Irvine designs special effects for television and is chairman of the Haringey Astronomical Society.

Peter Jewell is professor of physiology of reproduction at Cambridge University and has visited East Africa many times.

David Jones is the author of *The Inventions Of Daedalus* (Freeman).

Tony Jones is in the astronomy department, Manchester University.

Stephen Mills is an ornithologist and film maker.

Ashley Morton lectures in biology at Southampton University.

Norman Myers is a consultant in environment and development and lived in Kenya for 24 years.

Nick Saunders teaches archaeology at the department of adult education at Southampton University.

Richard Smith is assistant editor of the *British Medical Journal*.

Tales from the tomb

Tomb of the Eagles
by John W. Hedges, *John Murray, pp 244, £12·50*

Nick Saunders

POPULAR BOOKS on British archaeology tend to be either continual rehashes on Stonehenge, tomes turgid enough to serve to first-year undergraduates or flights of fantasy dealing with the magical powers of stone circles. Unlike the Americans, British archaeologists seem unable to spice their popular contributions with a smattering of anthropology.

John Hedges dramatically breaks the mould with this book about the discovery, excavation and interpretation of a neolithic tomb at Isbister on Orkney. By fleshing out the usually all too bare bones of neolithic archaeology with skilful insights, he has produced a balanced and readable account of life and death during the period around 3000-2000 BC. It is a tribute to this approach that Colin Renfrew, Disney Professor of Archaeology at Cambridge, needed no persuasion to write the foreword.

Local farmer Ronald Simison discovered the chambered tomb of Isbister in 1958, but for a variety of reasons the tomb was not excavated at that time. After participating with Renfrew in the excavations at the Quanterness tomb, Simison decided to investigate Isbister himself.

A recent gathering of Isbister's ancient inhabitants

What he discovered not only surprised him but was also of great significance to the archaeologists' understanding of the neolithic period throughout Britain. In the main chamber of the tomb and its associated side cells Simison discovered undisturbed burials of human bones and skulls, many disarticulated but set in discrete heaps. Mixed in with these remains were the bones of sheep, cattle, fish and carrion birds. As if this was not enough, a huge mound of smashed neolithic pottery weighing some 30 kilograms had been deposited near the entrance to the tomb. To his great credit as a skilled amateur, Simison collected some 16 000 bones and fragments, which are now deposited at the Tankerness House Museum, Kirkwall.

The bones told an exciting story. Human bones were always accompanied by the remains of birds—90 per cent of which belonged to the white-tailed sea eagle (now a rare sight in the area). The human bones had all the signs of being excarnated—being deposited in the tomb after exposure, possibly on wooden platforms, to the attentions of the carrion-feeding eagles. Here was a unique glimpse of the ritual disposal of the dead during the neolithic period. The eagle may well have been a totem and symbol of tribal identity, and there are many ethnographic parallels for such an assumption both in the Old World and the Americas.

Hedges's interpretations of Simison's excavations suggest that the tomb had been in use for some 800 years; it was built about 3150 BC and finally closed around 2400 BC. For the whole of this period the sea eagle played a central role in the elaborate burial rites. Isbister and other similar structures of the period, such as Maes Howe and Unstan, are some of Europe's oldest standing buildings and represented a huge amount of communal effort and political and religious incentive.

It is a tribute to all concerned with the Isbister excavations in particular, and the archaeology of Orkney in general, that British archaeology can look forward to a fuller picture of the nature of prehistoric societies. Their religious beliefs, political and socioeconomic behaviour are slowly but surely coming to light. ☐

After dinner entertainments

Advanced Paper Aircraft Construction MkII
by Campbell Morris, *Angus & Robertson, pp 34, £1·50 pbk*
Magie du Boomerang
by Jaques Thomas, published by the author*, *pp 200, FF199*
Super-Games
by Ivan Moscovitch, *Hutchinson, pp 126, £6·95 pbk*

John Bell

DON'T BE fooled by the title of Morris's booklet, the important word is "advanced", and beware of its mischievous touch. Making any of these clever little planes is bound to get you into trouble. You just try making the Air Hopper ("A graceful glider that will 'flap' its wings and hop through the air like a butterfly"), and the boss is certain to catch you at it. We recommend the reply: "It's all right, Sir, I'm writing a review." Morris would have loved the embarrassment of this reviewer who was forced to stutter out that explanation while standing on a desk trying to launch the wretched aircraft. One note of warning: this is not a book for an unsuspecting 10-year-old; some of the plans take a bit of working out.

Thomas once wrote an article for *New Scientist* explaining the physics of the boomerang, which managed to stop this office one day. Your reviewer (in trouble again) walked through the door, carrying a huge bag full of boomerangs of all shapes, sizes and colours, and bumped into the publisher. The publisher howled with laughter, followed by everyone else. And your reviewer suffered a serious collapse of dignity.

Please show Jacques there are no hard feelings by ordering a book from him. You will be rewarded with everything you ever wanted to know about boomerangs. In French.

My Dad once defined a crossword as the triumph of one warped mind over another. *Super-Games* is like that too, but in colour and without words. You will need lots of paper and a big box of colouring pencils to get the most out of this book. If you start on page one on the first day of Christmas, you will still be trying to colour your way out of trouble on the twelfth. For hard-working imaginations only. ☐

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Mathematical puzzles and illusions

Mathematical Magic Show
by Martin Gardner, *Viking, pp 284, £9·95*

David Jones

MARTIN GARDNER is an institution. The special field of mathematical diversions, which he has made his own, extends in some places to the cutting edges of mathematical research, and sinks in others into physics, psychology, philosophy and wordplay. In his celebrated "Mathematical Games" column in *Scientific American* (from 1956-81), he brought innumerable intellectual puzzles, problems and diversions to an audience which grew to contain thousands of correspondents and probably millions of loyal fans.

Though this book has been largely quarried from that past monument, it reads freshly, with no taint of scissors-and-paste. Gardner has enlivened and expanded his original material with later comments, quotations and stories from his indefatigable correspondents, and the useful bibliography at the end of the book directs the reader to still further material.

The 19 chapters cover such diverse topics as number theory (factorials, finger arithmetic), geometry (Möbius bands, the Dragon Curve, polyominoes), games and game theory (playing cards, dice) and philosophy (nothing and everything). Each chapter follows the same general pattern. Gardner introduces a topic, for example polyominoes, the various shapes that can be constructed from joined squares (the name is a generalisation from "domino", which has two such squares). He discusses the puzzles and problems, theorems and games associated with the topic, giving due credit to their discoverers. He also looks at related intriguing problems—such as that of fitting polyominoes together jigsaw-fashion to assemble a target rectangle. Finally, he gives the answers to the challenges thrown out in the course of the chapter.

Gardner's emphasis is on insight, understanding, and the strategy of reasoning. He has nothing to offer those grown-up little boys who just love to press keys, watch picturesque nonsense unfold on a computer screen, and imagine they are doing mathematics. But if you have the sort of mind to be caught by intellectual diversions, this book will surely have something for you. I personally prefer his purely mathematical problems—there is always a full and fair answer, however devious or impenetrable the logical route to it. But those who prefer the softer delights of trick questions, wordplay, multiperson games, or even philosophical musings, will find plenty to grab them too. Highly recommended, but be warned—mathematical games can be addictive! □

Searching to know the world

The Discoverers
by Daniel Boorstin, *Dent, pp 745, £15*

Richard Gregory

DANIEL BOORSTIN is a distinguished American historian, who won the Pulitzer Prize in 1973 for the final volume of his trilogy *The Americans*.

The Discoverers, subtitled "A history of man's search to know the world and himself", describes many technological discoveries and concepts of science, but the emphasis is on exploration. So it is sad that there are no maps to illustrate the journeys of the discoverers, or pictures showing what they or their ships or their instruments looked like. Unless one is a professional geographer, it is difficult to see the significance of the discoveries from words.

I have a deeper criticism—that there is not enough on what people thought before the discoveries, or why and how discoveries are made. The greatest adventure of humankind—explaining the Universe—is made to look almost flat.

The range of interesting comments and facts is commendably wide. But the discoverers seldom come alive as there is little space for the interesting details of their lives. In the case of Newton, I would question Boorstin's account of his background: Newton was not a poor serf, as a journey to his Woolsthorpe house makes obvious.

I cannot forebear quoting, with apologies to the author, what must be the most poignant misprint in the history of publishing: "The book as a whole is chronological. In detail it is a shingle scheme." □

Recycled rhynchosaurs

Pocket Book of Dinosaurs
by Michael Benton, *Kingfisher, pp 188, £3·95*

Beverly Halstead

ONE OF the most recent phenomena to burst upon the fossil scene is a young man, Mike Benton, who is currently by far the most prolific writer on fossil reptiles. He has made his name on his researches on the rhynchosaurs, which are commemorated by the *New Scientist* poster "The Age of the Rhynchosaurs". This was an important contribution, as it made a major dent in the dinosaur-dominated consciousness of the general, yet scientifically educated public. A brave and valiant attempt—but one has to record that, like many before him, Benton has not been able to resist the seductive blandishments of the dinosaur industry. Unlike his monographic treatment of his beloved rhynchosaurs, he has only succumbed to the extent of producing a "pocket book".

The main part of the book, from page 34 to 127, is taken up by a "dictionary of dinosaurs", in which they are dealt with alphabetically, albeit colour-coded into the major groups of the current dinosaur classification. There must undoubtedly be somebody for whom this approach is appropriate, but for anyone with a modicum of knowledge of dinosaurs, it is maddeningly irritating. Nice, however, to meet *Zephyrosaurus,* which was found in 1980. The introductory pieces, and the discussions on such topics as "warm-blooded dinosaurs", are extremely well written and are models of how this sort of topic should be handled. Benton is a fine writer, scientifically sound, and common sense pervades the book—and so it should. It is a very nice book that can be warmly welcomed, and would be well received in the Christmas stocking of many a little boy or girl this festive season.

Just a word of warning: Kingfisher Books is a Grisewood and Dempsey company, and it has produced dinosaur restorations for well over a decade. If many of the illustrations seem familiar, this is because they have appeared many times in many earlier books, over and over again. This is surely a splendid money-spinner for the firm as the artwork is continually recycled with only the words periodically changing. In this case the book is worth getting for Benton's text.

There is another aspect of the book that makes it especially appropriate for Christmas, and should enthrall the young dinosaurophiles, who will be able to devise splendid games with the adults whose mental faculties will have been dimmed by indulgence. In many of the illustrations (the older ones are hopelessly inaccurate), features of the heads and legs and the bits in between of members of very closely related groups, have wildly different appearances. Just look at their mouths for starters. Well, any 10-year-old can devise a suitable competition game at which they will undoubtedly always come out victorious. Buy the book; there will be hours of entertainment guaranteed. ☐

A comprehensive, scientific analysis

M. A. Harwell

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How to run a community

TELEVISION

Dennis Hackett

THERE WERE so many estimable things about Anglia Television's Survival Special, **Together They Stand** (30 November), that it is difficult to know quite where to begin.

What it portrayed was a uniquely organised community where selflessness is the norm and the divisiveness that characterises our own was nowhere discernible.

Readers of *The Guardian* women's page would certainly have loved it, for it was a community organised and dominated by a female, though British dissidents might sourly riposte that so is ours.

The subjects were African dwarf mongooses which, as Simon Trevor's film beautifully demonstrated, have hearts out of proportion to their size when it comes to mutual protection.

They also communicate effectively with a vocal vocabulary of a mere 18 distinctive sounds. When warnings are called for, it appears entirely adequate to frustrate the lethal efforts of martial eagles, black tit mongooses (much larger but with no fellow feeling for mongooses as a whole), and even the grey spitting cobra. The last we saw in pursuit of the 14-strong community, more than usually burdened by having four babies to protect. Several of the dwarf mongooses turned to surround it, relying on their speed to evade its strike. They succeeded, and the cobra, bemused no doubt by these darting furry figures, turned and departed in search of a less mobile prey.

The mongooses tend to suffer casualties only in their early months. Those which survive carry on to a ripe old age of 12 to 15 years. Survival is not easy. Each year the quelia birds come to hatch in their hordes and the mongoose territory, in addition to its normal complement of predators, is suddenly invaded by eagles and by marabou storks whose pendulous gullets obviously have room for both quelias and mongooses.

Trevor's film was meticulous in its detail, showing the different jobs of the community, soldiers, baby-sitters, lookouts, and all and including some excellent photography within the termite mound.

He explained and demonstrated the importance of play in creating bonds in the group and the population control exercised by the alpha female. She breeds only with the alpha male and eats the young of any other female rash enough to produce.

One thing remained unclear: just how a female dwarf mongoose got to be an alpha female, but in a superb film that is just a quibble.

Horizon's **The Global Village** (26 November) made a splendid effort to be balanced about India's efforts to make what science fiction writer Arthur C. Clarke called "a quantum leap" through space technology and make up for missing out on the industrial revolution.

India apparently has twice as many space scientists as Europe, and has her own geostationary satellite up there. Mrs Gandhi was an enthusiast and Minister of Space.

The 1970s experiment which equipped 5000 villages with antennae and communal television sets (the Satellite Instructional Television Experiment) and put out educational programmes was a technological success, but it had its sceptics about the real educational benefit.

There are sceptics still and producer Richard Keefe talked to them. The principal one was George Fernandes MP, who feared cultural destruction and possibly political control by a centralised system controlled by the ruling party.

There seemed to be something not quite right in investing so much hope in satellite television schemes in a country where growth is urban-centred and where the vast, rural majority lacks basic resources such as energy, clean water, and food.

Despite Keefe's fair play with the enthusiasts, I thought the sceptics tipped the balance. ☐

1984

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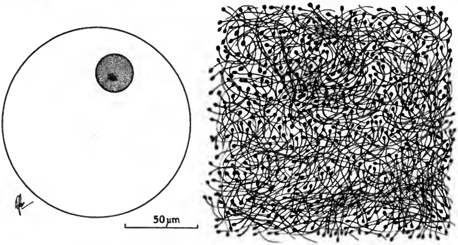
Mothers and fathers

There is more to fatherhood than is dreamt of in sociobiological philosophy argues Ursula Mittwoch

IT'S A WISE CHILD that knows its own father, and a lot more wisdom is needed to understand the biological facts of paternity. A hundred years ago it became apparent that fertilisation involves the union of a small sperm with a large egg cell. This fact was seen by some of our predecessors as "the small starving male cell" seeking out the well-nourished female cell. Present-day writers tend to be less quaint but not necessarily more accurate.



A human egg and 500 sperm; millions are needed to ensure fertilisation

Because of their small size, sperm are often regarded as cheaper to produce than eggs. For mammals, this assumption is highly dubious. The difference in volume between a human egg and sperm is of the order of a hundred thousand to one. But sperm are not made in ones or twos. If we multiply the five hundred spermatozoa shown in the illustration by a factor of one hundred thousand, we arrive at a figure of fifty million, which is frequently regarded as the lower limit of a normal sperm count. A count of five million would be classified as "severe oligospermia", with conception very unlikely to take place.

Apart from low, or rather insufficiently high, numbers of spermatozoa, the quality of semen can also be adversely affected by abnormally formed sperm. In the course of their maturation, both eggs and sperm undergo two meiotic (reduction) divisions, as a result of which the number of chromosomes they contain is halved. Following meiosis, the sperm cell has to undergo yet another process known as "spermiogenesis", during which the cell is modified into a highly complex structure that is able to swim and penetrate the egg. Both meiosis and spermiogenesis are intricate processes that are liable to errors and, indeed, cell death.

It has been known for a long time that extremes of heat and cold, as well as exposure to high altitudes and low atmospheric pressures, have an adverse effect on testicular function and fertility; recent research has revealed a large number of genetic anomalies that cause sterility in males. In the mouse, many chromosome anomalies, involving different chromosomes, are known whose only apparent effect is an interference with sperm production. In a recent review of the genetics of sterility in the mouse, Tony Searle, of the Medical Research Council Radiobiology Unit at Hanwell, concluded that the number of ways in which gametogenesis can go wrong seems to be much larger in males than in females.

Recent evidence suggests that chromosome anomalies may have an adverse effect on the production of eggs as well as of sperm. The reason why males carrying these anomalies are sterile while females are not could be connected with the fact that male fertility requires many millions of spermatozoa whereas a small number of eggs are sufficient for reproduction in females. At the level of gamete production, it may actually be less difficult to become a mother than a father.

In the past the "blame" for an infertile marriage was in most cases attributed to the wife. As a corollary, the problems underlying male fertility were almost completely unknown, and certainly underestimated. As our understanding of the male and female contributions to reproduction is improved erroneous ideas that have infiltrated into theoretical biology need to be revised.

One is that alleged cheapness of spermatozoa, males would naturally evolve towards promiscuity, and become owners of harems. The persuasiveness of this theory has led to a lot of effort being spent on studying animals whose reproductive behaviour supports it, like elephants, seals and red deer, in which dominant males mate with many females. Much less work, however, seems to have been done on the social organisation in packs of wolves, where the only mating taking place is between the dominant male and the dominant female. Why are the other females let off the hook? Could it be that wolves practise fertility control rather than maximise the number of their offspring?

When it comes to human families in developed countries, any explanations of social differences between males and females that are based on their reproductive roles ought to be discounted. At worst, such theories are merely deliberate attempts to perpetuate the *status quo* of women's low economic potential; and the shakiness of the underlying biology cannot usually be detected by the person in the street.

But aside from political arguments, the idea put forward by Richard Dawkins, author of *The Selfish Gene*, that men are driven by their selfish genes to have as many children as possible, runs counter to common experience. The phenomena of prostitution and homosexuality testify that promiscuity can be separated from procreation. And there is no biological law impelling women to devote their major efforts on behalf of their families. Who looks after the children is a social problem, not a biological one. □

Ursula Mittwoch works at the Galton Laboratory Department of Genetics and Biometry, University College, London.

There's an awful lot of micros in Brazil

K. K. Chawla on how one developing country keeps the multinational's at bay

THE MICROCHIP revolution has wrought big changes in Brazil in the past decade or so and at the moment is causing quite a furore. Having failed, or never attempted, to stop domination of industrial sectors such as the automobile and electro-domestic multinational companies, Brazil seems to have put its foot down rather firmly in the field of mini and microcomputers to protect its budding national industry.

Brazilians recognise that in the field of mainframe computers, their national industry is no match for giants such as IBM, Burroughs and Control Data. So, these companies are allowed to go about their business as usual in the field of mainframes. But in the field of micro and minicomputers the story is different. In 1975 micro and minicomputers represented only 17 per cent of the international market while in 1980 this share rose to 40 per cent, and it is expected that in the mid-eighties this figure will rise to 64 per cent. No wonder that giants such as IBM are also increasing their stakes in this area. But Brazilians reckon that in this new field they can and should develop on their own. ►

▸ This reasoning, coupled with the concept of national security, has led them to adopt a policy of "reserva de mercado" (reserved market): certain areas of the mouth-watering Brazilian computer market, estimated at US $1·75 billion, are forbidden to non-Brazilian companies. The latest legislation, establishing this policy as law until 1992, was passed in October this year. General Danilo Venturini, head of the National Security Council, has said, "The reserved market is not simply an economic measure but above all political".

Chips prime the Brazilian pumps

The US has been trying hard to make Brazil open the market but so far has not been successful. US Secretary of State George Shultz and others have been trying to inform the Brazilians of the risks involved in such a closed-door policy. Schultz told them during a visit to this country in no uncertain terms that "Any nation which resolves to follow its own path in this area [informatics], using its own resources, is doing itself harm". Lionel Olmer, US Subsecretary of Commerce, has warned that Brazil must realise that it will not be able to pay its debt just by exports. Brazil needs, according to Olmer, to stimulate foreign investments in its industry, and Brasilia's policy on high technology impedes these investments.

The Secretaria Especial de Informágtica, SEI (the Special Secretariat for Informatics) is the organ that guards Brazil's computer field. SEI is a unit of the National Security Council. Until very recently, SEI was headed by one Colonel Brazida. The present head is also an army man, Colonel Edson Dytz. All this highlights that the Brazilians consider the field of informatics as highly sensitive and associated with the country's security, an area too important to let the multinationals have a free sway.

It is said that Brazil woke up to the inherent dangers of foreign dependence in such a sensitive field in the early 1970s when the Brazilian Navy found that the Ferranti weapons guidance systems on some British warships that it had acquired were not operating and that there was very little it could do about it. This fear of dependence on foreign technology was further reinforced by the embargo on Argentina during the Falklands war.

Of course, not everybody is gung ho about SEI's performance. Many critics regard SEI as too bureaucratic, dominating and usurping the functions of the other organs, a perfect example of the hazards of government intervention in the market place, say the critics, with ultimately the consumer paying more for the product.

But the "closed-door policy" has produced tangible results. In 1976 there was not a single manufacturer which was 100 per cent Brazilian owned in the area of micro and minicomputers. Today there are about 140 Brazilian companies in the field. Between 1979 and 1983, precisely the period of recession, these Brazilian companies were responsible for a jump in sales from US $190 million to US $700 million. According to Edson Dytz, ten years ago, of the 8884 computers installed in Brazil, 17 per cent were national. Today, thanks to the reserved market policy, the share of the Brazilian companies has increased to 70 per cent of the market.

Take one example of the "silicon-valley" type entrepreneurship that is increasingly common in Brazil. Senhor Oliveira, 26, of Porto Alegre and owner of Chronos Produtos Eletronicos has recently signed a $1·3-million contract with Shell of Brazil to provide computerised gasoline, alcohol and oil pumps. Oliveira came to know that SEI had vetoed Shell's request to import such pumps. He immediately took a plane to Rio and informed Shell that his company could produce them. The other day I got my car filled with alcohol at one of the 10 prototypes working at a Shell station in Rio.

Oliveira, of course, thanks SEI more than his stars. And the only people who are unhappy are the multinational computer giants. There are, of course, many problems ahead. Software has, comparatively, not received so much attention and there is certainly a lack of qualified manpower in the area. But informatics is now the biggest draw in the universities and colleges. Whether the Brazilian "reserva de mercado" policy will continue to work, time alone will tell. ☐

Professor K. K. Chawla is at present on sabbatical leave at the University of Illinois from his post at the Institute Militar de Engenharia in Rio de Janeiro.

Strangers in paradise?

Derek Ager plays host to some fellow-travellers

YOU'RE VERY WELCOME comrades, but I wish your governments would understand some of the problems of organising international science. In spite of all the lip service to scientific cooperation between countries, anyone who has ever organised a meeting, or even a simple visit, will have experienced the frustrations and sheer desperation of bringing fellow workers from east of the Iron Curtain. Before the latest international geological symposium I organised, I received a letter which stated: "The Soviet delegation will consist of the following 11 persons . . . " There then followed a list of 14 names. Not to be unnerved I arranged accommodation for 14, and sorted them into males and females on the basis of the presence or absence of -ova endings to their names; I had forgotten that Georgian ladies do not have this distinguishing feature. Still, that did not confuse matters more than they had already been confused at the other end. The people who actually arrived turned out to be mostly quite different from those that we had expected, and, as usual, several of their specialisms were completely unrelated to the subject of the meeting.

When we had an earlier meeting on the Upper Jurassic, most of the Russians who appeared turned out to be experts on the Precambrian (and wanted to see something quite different from what we had arranged to show them). There is always the curse of the grand old men—the elderly academicians who are regarded as trustworthy—who turn up over and over again at meetings, regardless of the subject, but who have usually not worked actively in science for years. They have often travelled so much that they are completely Westernised and very sophisticated. I remember sitting beside such a Soviet geologist by the Black Sea while he told me Christine Keeler jokes that I had not heard in London (that dates my visit exactly).

With any large delegation from the East, there is always the quiet man whom no one has heard of (or invited), and who takes no part in the scientific discussions. Sometimes he is introduced as an interpreter, but we all know who he is. Once when we had everyone accommodated in the same

THE PARTY HAS DECIDED, COMRADE, THAT YOUR MATERIALISM IS NOT SUFFICIENTLY DIALECTICAL!
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student hall of residence there was an interesting episode in the middle of the night. One of the British geologists got up for the usual reason and found the Soviet delegation holding a meeting on one of the landings. This was being conducted by the quiet man, and evidently was a self-criticism session for one of the party who had misbehaved in some way (I think he had merely delayed a geological field trip by turning up late for the bus). Sometimes I have found visiting geologists unwilling to answer even the simplest questions about their country without reference first to the quiet man or to the leader of the delegation. This happened, for example, with a Chinese party when the talk got round to their educational system back home.

Whether it be big meetings or individual visits, the problems are immense. There was the Pole whose visa was withheld at the last moment without explanation, although he had previously spent six months in Britain without problems. There was the Romanian who was not allowed an air ticket, and who came all the way by rail from his distant country, to arrive in a state of exhaustion too late for the opening session. There was the Bulgarian whose visit had been postponed until the following year, by mutual consent, and who then arrived a year early at two days notice, because he had to seize the opportunity of a visa when it was offered to him.

There have been the international committees whose work has been crippled because of the unexplained and inexplicable non-arrival of colleagues from the East. I recently chaired a session at an international meeting in West Germany where three of the six speakers (all those from the East) did not appear. When I received an honorary degree in Paris, along with three other foreign scientists of diverse disciplines, it was the Russian mathematician who was not there to be honoured. Last year there was an international meeting in France specially convened to honour an eminent Russian geologist, but the guest of honour did not make it. Usually the excuse is ill-health, but the frequency with which it occurs suggests some sort of episodic epidemic affecting Soviet scientists. Never do they bring their wives or families, presumably as an insurance that they will go home again.

When they do come, even the most distinguished Eastern visitors cannot resist the material goods of the capitalist world. Our last Chinaman somehow took back with him a refrigerator (I only hope he got the right voltage). I have seen the most eminent Russian geologists crowding into a university bookshop to buy simple mundane things such as Sellotape and felt-tip pens. Just as she was leaving London, a Czech lady geologist asked for a copy of *Playboy*, which she had been commissioned to bring back from the depraved West by her male colleagues. The Chinese delegation on their way home on the plane via Moscow, all demanded copies of the *Mirror* or the *Sun* from the stewardess when she came around with the newspapers. After all the available copies of these particular journals had been distributed, they retired crestfallen to the little red book which was their standard reading at that time—but that is another story. ☐

Money for new technology

Anthony Wilson has some good news for science buffs

IT LOOKS as though Britain will soon have several new Science Centres. For years, travellers returning from the United States, have brought back tales of forward-looking science and technology museums, unencumbered by historical collections, whose displays blend entertainment with education through a strong commitment to visitor participation. In Britain, only London's Natural History Museum (or more properly the British Museum (Natural History)) with its new generation of didactic multi-media exhibitions has wholeheartedly reflected the trend. Now a fund has been set up to help to establish a network of centres in Britain, and several new ventures are already under way.

Many of the new centres will concentrate solely on providing what are known in the trade as fully interactive exhibits—experiments and demonstrations which visitors can do for themselves, without the barrier of glass cases, push-buttons and remote control devices, but with the assistance of "helpers" or "explainers" when necessary. Another feature of the British proposals is that some of the centres will be strongly biased towards engineering and applied science—Technology Centres in fact.

One new centre is already open, the Micrarium in Buxton, Derbyshire, where visitors explore and observe with specially adapted microscopes.

In London more than 100 000 people have explored the Science Museum's experimental Discovery Rooms, and a permanent, fully fledged interactive technology centre, called "Launch Pad", will open within the existing Museum in 1986. Provincial science museums are watching with interest and some are keen to follow suit.

Another variant on the same pattern was opened as a pilot scheme in Portsmouth in 1982 and its backers, a group of enthusiastic educators and engineers, have now produced plans for a permanent version. The most ambitious proposals to date are for the Bristol Exploratory (*New Scientist*, 17 November 1983, p 484), whose prototype exhibits delighted visitors at this summer's meeting of the British Association for the Advancement of Science in Norwich, and for a "Children's Experience Centre" which, though rather different in concept, also combines a commitment to participation with a slant towards technology.

Interest is growing, too, within the tourism and leisure business, and more centres may come from that sector. No one has yet suggested replacing the Longleat lions with interactive science exhibits, but it could happen.

Although there is wide agreement that Britain badly needs a network of interactive exhibit centres, few of these schemes have yet found full financial backing. They survive on goodwill and short-term grants in the hope that once the first few ventures prove themselves, the rest will attract support more easily. Encouragement has come from the setting up, by one of the Sainsbury family charitable trusts, of a fund that will make grants of seed capital to help establish five or six technology-based interactive centres around the country.* Other charities might like to note.

Pete Addis

Hands-on experience at Bristol Exploratory, where every exhibit presents an opportunity to learn through experience

It is not hard to justify putting money into Science and Technology Centres. They are undoubtedly popular: 40 million people go to them each year in North America. Visiting them is enjoyable and stimulating; it motivates people and sharpens their awareness of science and technology. This in itself should justify setting up a network of centres in a country that says it is chronically short of good engineers and technologists. ☐

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* Details are available from the Fund for the Development of Interactive Technology Centres, c/o Science Museum, Exhibition Road, London SW7 2DD.

Anthony Wilson is Head of Education at the Science Museum in London.

Don't look now

Barry Fox has a feeling of *déjà vu* at the movies

ACTION SCENES in the cinema and TV films often look strangely familiar. The same tanks are blown up, and the same aircraft crash, in different movies. Almost every film about flying has the same sequence of hilariously futile failures; the flying bedstead that falls apart, the back-pack rocket that fizzles out and the multiwing craft that collapses into a heap of matchwood. This is all the result of a brilliant idea by a film-maker called Sherman Grinberg.

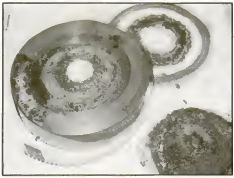
Film studios are always short of cash and storage space. Thirty years ago, Grinberg visited all the major film studios in the US and offered them hard cash for the right to store and lease out their non-identifiable stock shots. When a film company makes a major movie it spends heavily on location shooting, stunt work and special effects like explosions. Most of the film shot has no recognisable faces. These are known in the film trade as stock shots. The stars appear in a few safe scenes which are spliced in between the stock shots. Grinberg reasoned that the live-action footage could be used again and again.

The studios jumped at the idea of making money on expensive material that would otherwise be dead. Although Grinberg himself is now dead, his library thrives on in Hollywood. It holds all the stock footage for 20th Century Fox and MGM. He also bought their out-takes, the shots which were never used in the final version of the film for which they were shot. The library has footage from almost every picture the Fox and MGM studios made.

If you want to make a films about Roman transport technology and need a few shots of chariots racing, the stunt work for Ben Hur is there for the buying. If you are making a company video about safety at sea, there are all the action sequences from the Poseidon Adventure. The only rule is that you cannot buy any shots, like the liner turning turtle, which clearly identify the original source. None of the stock shots has recognisable stars in view, so there is no hope of creating an alternative version of *Gone with the Wind*.

Using stock material is not cheap. On average it costs $1500 for 10 seconds. But that is still far cheaper than sinking a ship, or organising a chariot race. Some material is not available, at any price. The World War One dog fights from *Hells Angels*, shot by Howard Hughes, are untouchable. Recently Fox withdrew all the stock war footage from *Patton* and *Tora Tora Tora*. Film buffs see this is an early warning of some new blockbuster which will save money by reusing action sequences shot for films which are now largely forgotten.

The astute Mr Grinberg also tied up the newsreel libraries. His library has literally millions of metres of Pathe, Paramount and ABC news coverage, most of it indexed on a computer data base. That is where all those shots of the flying failures come from. Pathe News produced a short called *Mechanical Age*. It collated all the newsreel material of flight failures since cinematography began. Grinberg got it as part of the Pathe News job lot. Now the library sells excerpts at least once a week.


Barry Fox

One that got away

Handling old film is not the licence to print money it might first appear. Until the early 1950s, all cinema film had a nitrate base. Chemically it is like gunpowder. Nitrate film can explode. Less dramatically, it can be relied on to disintegrate. The film on the reel turns sticky, corrodes the metal can containing it and finally turns to rusty dust. As nitrate films breaks down it releases a chemical similar to laughing gas. One Hollywood film librarian asked his doctor why he felt high at work. The doctor diagnosed old film.

The Grinberg vault is fighting a losing battle with its nitrate newsreels. Even the fat profits earned from selling Pathe's flight failures once a week cannot pay for a project to transfer half a century of nitrate news onto modern stable film stock. All the Grinberg archivists can hope is that the reels which must inevitably turn to gas, dust and rust will not include a newsreel sequence which suddenly becomes historically significant. Sod's law, well known to anyone who deals with the real world, says it will. □

Third World agriculture and maths

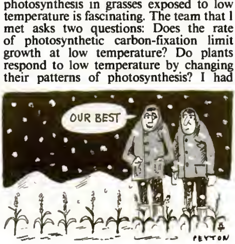
Some winter leaves from Westminster

THISTLE DIARY

Tam Dalyell MP

HOW MUCH should we be helping developing countries? The graphic pictures from Ethiopia provide an urgency as never before. The immediate need is for food and medical supplies. But what should we do in the medium and longer term? I really wonder whether Britain should not provide more places for overseas students in some of our institutes and universities. For example, I visited the Welsh Plant Breeding Station at Aberystwyth in the third week in November. I saw lots of work in progress that is highly relevant to Third World problems. If the Agricultural and Food Research Council had more money from the government, its research stations could take on more graduates from home and abroad—to the advantage of foodproduction in developing countries, and to the self-interest of Britain.

The work of the Aberystwyth station on photosynthesis in grasses exposed to low temperature is fascinating. The team that I met asks two questions: Does the rate of photosynthetic carbon-fixation limit growth at low temperature? Do plants respond to low temperature by changing their patterns of photosynthesis? I had always imagined that there was a direct, or at least positive, correlation between resistance to frost and low temperature growth, so I was amazed when I was told that no such correlation exists. My hosts could show the rapid accumulation of carbohydrate reserves in cold-treated plants. Such accumulation, I was informed, can only occur when the photosynthetic capacity is in excess of the carbon requirement of the rest of the plant.



The station's research aims to identify the components of the photosynthetic process which show "acclimation", and to determine the significance of these effects in increasing carbon-fixation during the winter. Think of it—the potential for more rapid spring growth is enormous, with all the consequences that flow for increased production. Coupled with the work at Aberystwyth on semi-arid conditions, the contribution that the institute can make at home and abroad is enormous.

* * *

TO FOLLOW UP reports some years after they were published is a useful parliamentary exercise. Shortly before he died, the late Sir John Cockcroft, atom-splitter, Nobel laureate and master of Churchill College, Cambridge, completed his report on mathematics teaching. When Michael Stern (Bristol NW) quizzed the under-secretary at the Department of Education and Science, Bob Dunn (Dartford), on such matters, the latter replied somewhat enigmatically. "The government has maintained the number of initial teaching places in mathematics within a total provision of training places for intending teachers." And this, the minister claimed, had been achieved even though the number of secondary teachers had been reduced because of falling school rolls. It left me wondering whether Dunn was talking about real numbers or percentages (sticky business, mathematics!).

Be that as it may, ministers say that the recruitment to postgradute courses in mathematics has been good over the past four years, and that they expect the supply of newly trained mathematics teachers to be adequate in relation to the number of vacancies for them.

In November 1977, which is said to be the latest year for which information is available, it was estimated that 29 per cent of mathematics teachers in maintained schools in England and Wales did not have a recorded qualification in mathematics. (No information, however, was collected or recorded about qualifications at or below A-level.) However, a new survey of secondary school staffing was undertaken in January 1984, and I gather that the results will be available shortly.

Sir Keith Joseph says that he wants to see a reduction in the amount of teaching undertaken by teachers whose qualifications are not well matched to their task. The steps which the government is taking to achieve this were set out in the White Paper *Teaching Quality*. Ministers are putting their faith in the grant paid to local education authorities to enable inadequately qualified teachers of mathematics in secondary schools to be released for further training. Going around the country as I do, visiting various science establishments, I hear many complaints about the inadequacy of maths teaching in local schools. Important as qualifications are, teachers *per se* are born rather than made. ☐

ENIGMA

No 286

Final analysis by Martin Hollis

		A	B	C	D	E	F
Alapin	A	–	$\frac{1}{2}$				$\frac{1}{2}$
Bishop	B	$\frac{1}{2}$	–	$\frac{1}{2}$		$\frac{1}{2}$	
Colle	C		$\frac{1}{2}$	–			$\frac{1}{2}$
Dragon	D				–	$\frac{1}{2}$	$\frac{1}{2}$
English	E		$\frac{1}{2}$		$\frac{1}{2}$	–	$\frac{1}{2}$
French	F	$\frac{1}{2}$		$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	–

THE DIAGRAM shows all the draws in the recent Golden Rook all-against-all chess tournament. In all other games, the winner scored 1 and the loser 0. Play was in five rounds with three games each.

"How did you do?" I asked Alexander Alapin.

"Not well," he replied. "Ferdie French and I were so worn out by our first round draw (with each other) that we came equal bottom, behind all the rest."

"A lot of draws!" I remarked .

"Yes. At least one in each round, with each player drawing in at least two consecutive rounds."

There were two equal winners. Given that they did not meet in the second round, can you work out who they were and whom they played in the final round?

A £10 book token will be awarded to the sender of the first correct solution opened on Wednesday, 19 December 1984. Please send entries to Enigma No 286, New Scientist, *Commonwealth House, 1-19 New Oxford Street, London WC1A 1NG. The Editors decision is final. The winner of Enigma No 283, "EI EI Oh!" was Yan Dayon of Wimbledon.*

Answer to Enigma 283

EI EI oh!

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FEEDBACK

FEEDBACK'S GOLD MEDAL for dedication to scientific truth must go to Clair F. Bee, the weapons training officer of the Department of Correctional Studies, in Albany, New York. Bee had the unpleasant task of trying out a new gun for spraying CS gas at riotous crowds. His write-up appears in the form of a memo from "Clair Bee" on the subject of "Clair F. Bee". He exposed himself to the gun in a "slight crosswind" at a distance of six metres for about two seconds.

Result: "Total incapacitation, total impairment of vision . . . sneezing and copious amounts of mucous. Tightening of chest, weakness in arms, legs, muscles. Immediate burning sensation over all parts of body." Bee had to be led away by a colleague, and had a "severe headache lasting for three hours".

Bee, of course, was undaunted: "After decontamination, with the exception of the headache, subject was able to return to his assignment."

The silver medal goes to Michael Shearin, from the Department of Corrections in Missouri. He acted as a similar guinea-pig. Unfortunately the experience seems to have had a long-term effect on him: "While the specific name of the device demonstrated escapes me at the present time, its effects were unforgettable," he reports. ☐

SORRY TO RETURN to the problem of *New Scientist's* telephones, but John Gribbin reports that his new extension has two buttons marked "4" and none marked "5". This of course explains the absence of articles about ice-ages and heatwaves in our pages over the past fortnight. ☐

ANOTHER stirring tale of telephonic derring-do, this time from the US's invasion of Grenada. A squad of Marines, cut off from the main force, found its radio was on the blink. After some thought, someone suggested that the team capture a bar with a public telephone, and ask Uncle Sam to contact their comrades.

The pub and public phone were taken, apparently without bloodshed. Unfortunately, about all the US dollar and the East Caribbean dollar have in common is that each has 100 cents.

The Marines had to transfer the charge to Fort Bragg, North Carolina. Of course Fort Bragg refused to accept the call.

Finally, one of the soldiers admitted to owning a telephone credit card. The call was made on his account, and Fort Bragg radioed the main American force not to throw bananas at the lost squad. ☐

WITH CHRISTMAS approaching, it is time to spare a thought for our less fortunate brothers and sisters around the world. We refer, of course, to the agricultural researchers in Her Majesty's loyal colony of the Falkland Islands.

A correspondent writes that "being so far from the UK, we seem to be missed out from the annual round of calenders and other free gifts." Public-relations people, here's your chance to be appreciated. Send your goodies to: Agricultural Research Station, Port Stanley, Falkland Islands, South Atlantic. ☐

STEAMING open electronic mail is a pastime with a growing following. The Duke of Edinburgh and Elton John are among the many whose electronic mailboxes have been rifled by computer hackers.

But even those who supply the electronic mail are not immune. Our sources tell us that senior management at British Telecom, who use Telecom's own Gold electronic service, have fallen victim to the hackers. ☐

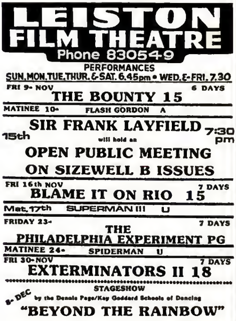
A SECOND-HAND Chinese typewriter for sale in London comes with the following instructions. 1: Learn to recognise Chinese characters. 2: Become familiar with them in reverse . . . ☐

MORE AMMUNITION for conspiracy theorists. People living close to the controversial Sizewell nuclear site were denied a chance last week to see a television programme about the effects of the Three Mile Island accident in Harrisburg, Pennsylvania. A power failure struck the Suffolk villages five minutes before the programme was due to be transmitted.

The Central Electricity Generating Board hotly denied that the blackout was anything to do with its "department of dirty tricks". Many locals would not put such a stunt beyond the board.

However, the power cut did not stop the Mayor of Harrisburg, who was staying in the area, from watching the programme. Stephen Reed was in Britain to give evidence at the Sizewell inquiry about the aftermath of the incident five years ago at Three Mile Island. He is not impressed with pressurised-water reactors.

When the lights went out, Reed's host, a parish councillor, found a portable TV and plugged it into the dashboard lighter of his family car. Thus Reed and his host watched the programme hunched up in the front seat. It was, Reed said, an example of the Blitz spirit. ☐



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FILM THEATRE
Phone 830549
PERFORMANCES
SUN.MON.TUE.THUR.&SAT. 6.45pm • WED.&FRI. 7.30

FRI 9th NOV 6 DAYS
THE BOUNTY 15
MATINEE 10th FLASH GORDON A

15th SIR FRANK LAYFIELD 7:30 pm
will hold an
OPEN PUBLIC MEETING
ON SIZEWELL B ISSUES

FRI 16th NOV 7 DAYS
BLAME IT ON RIO 15
Mat. 17th SUPERMAN III U

FRIDAY 23rd 7 DAYS
THE
PHILADELPHIA EXPERIMENT PG
MATINEE 24th SPIDERMAN U

FRI 30th NOV 7 DAYS
EXTERMINATORS II 18

STAGESHOW
8th DEC
by the Dennis Page/Kay Goddard Schools of Dancing
"BEYOND THE RAINBOW"

Nice to see that the distinguished inspector at the Sizewell B inquiry gets a bigger billing than both Flash Gordon and Superman

LETTERS

Astro logical

Why do astronomers get so steamed up about astrology? (*New Scientist*, 15 November, p 9). Churlish, surely, when it provided motivation and funding for their science for millenia. The palpable correlation between the behaviour of the "larger" heavenly bodies and events on Earth made astrology inherently plausible to our forebears. Even if there remains no likely mechanism whereby the stars might influence us directly, to dub astrology "pure fiction" risks being as dogmatically unscientific as the worst of present-day astrologers.

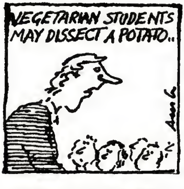
Date, or at least season, of birth might well influence personality: for example through exact age of entering school; relative age in school class; whether one spent one's formative months crawling about a garden or a carpet; and so on.

Could increasing belief in the paranormal in modern times be an understandable reaction to the appalling hubris and want of historical perspective of many scientists who lack the humility to accept that their work too will be debunked and that such extinction plays an inevitable part in the evolution of human understanding?

G. H. D. Darwall
Chippenham
Wiltshire

Carve up

I was saddened by a recent lapse of Ariadne's wisdom and humour (18 October, p 100). In my opinion, dissection has a vital role in the civilised education of biologists and physicians. In my experience, practical dissection is the only route to some essential knowledge and skills; to deny these to the serious student is, polemic aside, uncivilised. By all means minimise the slaughter by reserving dissection for the truly interested; demand that killing is as fast and painless as possible; encourage alternative modes of study wherever practicable; and above all, nurture a humane and ethical framework for our children's interactions with living organisms.


VEGETARIAN STUDENTS MAY DISSECT A POTATO..

Ariadne and the British Union for the Abolition of Vivisection please note: knowledge, and free enterprise, will find a way regardless: can't you see the latter-day Burkes and Hares around the schools—"Pst, fresh rats, pithed frogs".

David G. Cook
Department of Fisheries and Oceans
Ottawa, Ontario, Canada

Dirac

Your profile on P. A. M. Dirac was very well done and presented an admirable picture of an awesome man (Forum, 8 November, p 42). However, Professor Davies's research was shockingly lax in one area: the institution where Dirac spent his later years is Florida State University in Tallahassee, Florida, not the University of Tallahassee.

Indeed, as Davies described him, Dirac was "taciturn and retiring"; I wasn't even aware of his presence at FSU until my senior year there.

Miranda Davis
Wesleyan University
Middletown
Connecticut

* * *

In his excellent obituary of Paul Dirac, Paul Davies could have mentioned that "the greatest British scientist since Newton" was British courtesy of a Swiss father.

Charles Adrien Ladislas Dirac, Paul's father, was born in the town of Monthey in the Valais. He was apparantly quite unhappy in his childhood and ran away from home as a very young man. His "Odyssey" led him to Bristol, where he became a teacher of French. He resurfaced in Switzerland only 12 years later, when he was already a father of two, including young Paul. By that time Paul's grandparents had moved to Geneva.

There are no Diracs living in Monthey presently, but quite a few in the nearby towns of Martigny and Saint Maurice. Several of the Saint Maurice Diracs are cabinet-makers and specialise in the manufacture of coffins.

Lucien F. Trueb
Forschung und Technik
Zurich
Switzerland

Homoeopathy

Before publically airing his bias on the subject of research in homoeopathy, Geoff Watts (Forum, 15 November, p 53) should have checked the references. Contrary to what he "recalls" (sic), Gibson *et al* showed homoeopathy to be effective to a high degree of statistical significance, on a range of clinical parameters in rheumatoid arthritis (*Br J Clin Pharm*, 1980, vol 9, p 453). If there were any criticisms of this study, I have yet to hear them, and I am actively involved in the field. The "methodologically flawed" study which Watts recalls is presumably the previous publication of the same group (*Br J Clin Pharm*, 1978, vol 6, p 393), which was indeed criticised. However, the study which showed no difference between homoeopathy and placebo (*The Lancet*, 1983, vol 1, p 97) was also criticised (*The Lancet* 1983, vol 1, p 305, 482), which fact he does not recall.

It is ironic that, in defending the idea that conventional medicine is purely scientific and ideology-free, Watts's omissions eloquently speak for the opposing view. Although the reference to homoeopathy is brief it contains two separate biases: the study which showed a result unequivocally favourable to homoeopathy is selectively forgotten, despite the fact that it is the only one of the three to be free of serious criticisms; the study unfavourable to homoeopathy, but containing methodological flaws, shows homoeopathy to be ineffective; whereas a favourable study, also with methodological flaws is "methodologically flawed" and no conclusion drawn. Such inconsistency of interpretation is not objective.

No doubt this bias is unconscious, but is only the more pernicious for that. Certainly such attitudes are by no means uncommon among doctors and medical scientists, and are multiplied manyfold in attempting to obtain the support and collaboration necessary to carry out scientific studies of homoeopathy. We are currently attempting thorough and objective studies of the effects of homoeopathic treatment, and I hope that our results will be received in the same spirit, no matter whose prejudices they may conflict with.

Peter Fisher
Department of Rheumatology
St Bartholomew's Hospital
London EC1

Purse strings

I was intrigued by the article on "Robertson's amazing collapsible box" (Technology, 22 November, p 24).

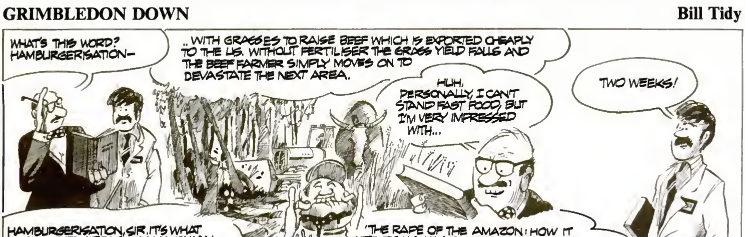
A few years ago I returned from holiday in Morocco with a leather purse I had bought from a genial Arab stall-holder there. It worked on an identical principle to that of Robertson's box and would cheerfully collapse to swallow a handful of change with the merest of taps on its rim.

When I got back I showed it to my mum. She, however, was not impressed, saying she'd had an identical one when she was a little girl. There must be a moral in this somewhere!

Chris Phillips
London SE11

GRIMBLEDON DOWN

Bill Tidy


WHAT'S THIS WORD? HAMBURGERISATION—
HAMBURGERISATION, SIR. IT'S WHAT HAPPENS TO AREAS OF AMAZONIAN FOREST WHEN CLEARED, AND SOWN...
.. WITH GRASSES TO RAISE BEEF WHICH IS EXPORTED CHEAPLY TO THE US. WITHOUT FERTILISER THE GRASS YIELD FALLS AND THE BEEF FARMER SIMPLY MOVES ON TO DEVASTATE THE NEXT AREA.
HUH, PERSONALLY, I CAN'T STAND FAST FOOD, BUT I'M VERY IMPRESSED WITH...
'THE RAPE OF THE AMAZON: HOW IT AFFECTS US ALL.' THERE'S A LOT OF HARD WORK AND RESEARCH IN IT. CONGRATS, IT MUST HAVE TAKEN—
TWO WEEKS!

In the soil

As Steve Connor's article "Digging holes in soil research" (22 November, p 10) makes clear, Britain cannot afford to leave basic soil research to the vagaries of private enterprise. But it is not just in the sphere of agriculture that such cost-cutting proposals are to be assessed. Farming is increasingly seen as part of the natural environment, and sometimes its methods are rightly judged as being unnecessarily destructive.

In this area of emotive confrontation hard facts about our soils are essential. For example, the environmental issue of the next decade may well be soil erosion. Recent Soil Survey data show that 44 per cent of Britain's arable area is at risk of erosion. This is a disturbingly high figure but one that can be drastically and relatively simply reduced by heeding Soil Survey advice.

Erosion is both an environmental issue (because we are degrading a scarce resource) and an agricultural one since crop yields can be maintained only by greater inputs of high-cost fertilisers.

Rational debate on environmental issues depends on hard facts being available. This is the wrong time to cut an organisation which provides those often uncomfortable hard facts.

John Boardman
Countryside Research Unit
Brighton Polytechnic
East Sussex

Drug injection

In his report on the new NHS regulations about prescribing cough mixtures Frank Lesser tells us that "100 cough medicines with names that tell nothing . . . will be replaced by six medicines with such simple titles as Diamorphine Linctus BPC or Methadone Linctus BP".

Diamorphine is, of course, better known as heroin, and methadone is a substitute narcotic. I thought the DHSS was trying to discourage prescribing of junk medicines.

Robert Eagle
London W4

* * *

In his short article entitled "Valium banned from NHS in drugs overhaul" Frank Lesser states that 28 of the 31 approved medicines are pharmacopoeial preparations. He further states that no standards yet exist for the three benzodiazepines listed. In fact the British pharmacopoeia does contain standards for diazepam and nitrazepam. A specification for the third benzodiazepine listed, temazepam, is in course of preparation.

C. A. Johnson
British Pharmacopeia Commission
London SW8

Museums

The article "Museums for the people" by Steven Griggs (15 November, p 34) has stimulated me to put pen to paper to make a plea for the specialist. A few years ago I brought undergraduates studying human biology and ecology to the museum to see the new exhibits and some of the traditional galleries.

After my students had seen the various exhibits and galleries I asked them to evaluate the visit. They all agreed that the new exhibits appealed more to the senses than the old, but felt that the information offered was pitched to a rather low intellectual level. Fine for the majority of visitors, but not much to offer a specialist.

The fossil mammal gallery, although I agree with Roger Hamilton about its lacking a theme, was the only gallery where information seemed to be pitched at more than one level. Large labels for the non-biologist and smaller, more informative labels for the biologist.

The human-biology exhibit was praised for technical presentation, but far less for information for the specialist. Steven Griggs pointed out that this was the most popular exhibit and surely this is not very surprising, because if there is one thing human beings are interested in, it is themselves.

The older galleries were considered to have plenty of specimens set in uninspiring displays with mainly taxonomic information, while the ecology exhibit was thought to lack specimens and specialist information, but not small children rushing about pushing buttons.

Steven Griggs suggests that people will vote with their feet, and I wholeheartedly agree. I no longer take my specialist groups to the Natural History Museum, but we still regularly visit London Zoo, where the education department seems well able to offer adequate information to generalist school parties and specialist undergraduate groups. The Natural History Museum has such a wealth of specialist information stored "behind the scenes". I do hope that new exhibits and galleries will be able to include something for the specialist or that there is an easing of access to undisplayed specimens.

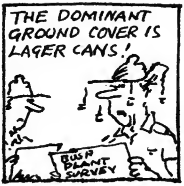
Lastly, I wonder why Steven Griggs did not include the Tring branch of the Natural History Museum in his study. When I visited Tring earlier this year I was amazed to find this very traditional museum, lacking in any new exhibit, absolutely packed tight with visitors of the generalist type.

Leslie Allen Williams
The Hatfield Polytechnic
Hertfordshire

Australian bush

An experiment is taking place in North Australia that may have far reaching repercussions in the utilisation of native bush for commercial purposes. The landscape here is littered with ecological disasters coming from ill-conceived plans of large-scale clearing for exotic monocultures.

Recent investigations, however, have shown that a small native tree, *Terminalia ferdinandiana*, carries a small edible berry with a vitamin-C content of up to over 3100 mg per 100 g of edible pulp, compared with 50 mg for oranges. The tree is common close to Darwin and in some areas of undisturbed bush constitute a major part of the system.


THE DOMINANT GROUND COVER IS LAGER CANS!
BUSH PLANT SURVEY

Attempts are being made to explore the possibility of exploiting the plant in its native state by selective clearing. The area will then be enhanced by planting superior strains and planning to retain a balance of other native trees.

There must be countless other species as yet untapped that could serve a similar purpose in other ecologically sensitive areas. This approach to development may go some way towards catering for the inevitable population growth that seems to please Fred Pearce ("In defence of population growth", 12 August, p 9).

Brian E. Woods
Casuarina
Northern Territory, Australia

British science

Regarding the article "The writing on the wall for British science" (8 November, p 25), while overall lack of funding is the prime difficulty, it may induce particular constraints in specific areas. Thus projects submitted for funding may be rejected, though theoretically worthwhile, if evidence is not already available that they will work. This may restrict innovation. Large established units may get preference because they are already well equipped, yet some may have also developed their own orthodoxy. There is often a tendency to continue with a particular line of research simply because the expensive equipment is there.

The extreme competition among students, from O-level onwards, possibly tends to favour those who conform and to exclude those with originality, unless very exceptional. The pressure of the packed timetable at university level probably discourages the habit of speculation. The automated literature search precludes "looking over the fence", which is perhaps the main stimulus to lateral thinking. All these trends conspire to limit originality.

Finally, how often do original ideas remain unpublished because reviewers fail to recognise them?

Margaret Ryle
Stocksbridge
Sheffield

Horse droppings

Chris Reynolds's review of "The Silicon Idol" (6 September, p 34) quotes, as an example of technological inertia, "the limitations on the size of containers which results from the gauge of railway lines". This could be extended by examining the railway line gauge itself, which derived from the size of existing horse-drawn carts and carriages. By linking these two examples, it can be inferred that container sizes are based on the dimensions of a horse's arse.

John Gratwick
Halifax
Nova Scotia
Canada

War heads

Your article "Can computers legally launch warheads?" (This Week, 25 October, p 7) quotes me as stating "The president clearly has the constitutional right to use nuclear weapons"; and goes on to state that I believe a Greenham Common lawsuit questioning this is doomed to failure.

Though the difference may seem slight, an accurate reflection of my opinion would be "The political branches clearly have the constitutional right to use nuclear weapons". The political branches include both Congress and the President, and I assert that delegation of a launch decision to error-prone machines clearly surrenders the mandated war powers of both political branches.

The Greenham Common case, which I wholeheartedly endorse, differs in that it challenges the *de facto* exclusive right of the President to launch such weapons, independent of an explicit Congressional affirmation. Unfortunately, such arguments did not meet with success in the courts re such incidents as the Cambodian escalation of the Vietnam war, for the approval of military funding by Congress was construed as adequate Congressional authorisation.

In this sense I believe my lawsuit has greater chance of success; but nevertheless I hope that the unprecedented threat of nuclear annihilation, viewed in the light of the constitution's express bars against unilateral Presidential acts of war, will convince the courts that not only is delegation of launch authority to error-prone machines illegally non-republican, but also any nuclear launch requires the real-time participation of Congress.

Clifford Johnson
Information Technology Services
Stanford University
California, USA

We welcome letters from our readers. Short communications stand the best chance of publication. We reserve the right to edit the longer ones. Write to: Letters to the editor, *New Scientist*, Commonwealth House, 1-19 New Oxford St, London WC1A 1NG.

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Appointments and situations vacant

ST MARY'S HOSPITAL MEDICAL SCHOOL
(University of London)
Norfolk Place, London W2 1PG

Applications are invited for the following two posts funded by the Cancer Research Campaign.

RESEARCH ASSISTANT
STUDY CO-ORDINATOR

required to join a group concerned with inherited susceptibility to cancer to take responsibility for coordinating studies in various centres in cancer patients. A knowledge of epidemiology, computing and statistics would be an advantage, but candidates with a background in life sciences will also be considered. Applicants should have a PhD degree or be graduates with an equivalent research experience. Salary depending upon qualifications and experience, on Research Assistant scale.

RESEARCH NURSE

The successful candidate will work closely with the above appointment and will have responsibility for patient investigation. The post involves interviewing of patients and supervision of metabolic investigations. The position would be suitable for someone with nursing experience or with experience of patient interviewing. Salary negotiable (Research SRN), depending upon experience.

Applications should be made in writing to the Assistant Secretary (Personnel) at above address by 4 January, 1985.

BREWING RESEARCH FOUNDATION

SCIENTIST

The Brewing Research Foundation, the brewing industry's corporate research centre, located in attractive surroundings near Nutfield, Surrey, is recognised internationally for its scientific and technological achievements. The research effort is interdisciplinary and targeted towards specific objectives.

The Foundation's Malt and Wort Production Section now seeks an innovative Scientist, to work on projects within the Section on malting barley and/or the production of wort from brewing raw materials. Candidates should already have a PhD in chemistry or biochemistry or a related scientific discipline and preferably have at least 12 months post doctoral experience in industry or at a university. Experience with modern methods for fractionation and analysis of carbohydrates and proteins would be an advantage.

Salary will be according to age, qualifications and experience. Applications, including curriculum vitae and names of two referees should be sent to: Mr Alan Clapp, Assistant Director, Brewing Research Foundation, Lyttel Hall, Nutfield, Redhill, Surrey RH1 4HY, quoting reference: SMW/24.

RESEARCH IN SATELLITE COMMUNICATIONS/DIGITAL SIGNAL PROCESSING

Following successful satellite trials in the UK and the USA of the prototype Digital Pseudo Analogue (DPA) Modulation System for DBS, and the placement of a research contract by General Electric (USA), the Department of Communication Engineering is seeking a Research Assistant or Fellow with a background in digital electronics and an interest in digital signal processing.

Candidates must have a good first degree preferably in Electronics or Physics, and/or a postgraduate qualification. Initially appointed for a two year period, the successful candidate, if not already qualified, will be expected to register for a higher degree.

Some travel to the USA/Canada during the project is anticipated.

Starting salary, dependent upon qualifications and experience, will be within the salary range circa £7000 to £10 000.

Application form together with further details are available from the Personnel Officer, Plymouth Polytechnic, Drake Circus, Plymouth PL4 8AA. Telephone (0752) 264639.

Closing date for applications 11 January, 1985.

Plymouth Polytechnic

TECHNICAL SERVICE CHEMIST

Multi-national detergent and chemical speciality company is seeking qualified candidates to fill key support position at their UK based Technical Centre. The position is responsible for providing response to technical enquiries on cleaning, sanitising and speciality product applications from direct sales force and customers in the food processing, and Institutional catering/laundry detergent business.

Position offers a highly competitive salary, attractive benefit package and modern laboratory working environment.

Typical qualifications would include a degree in chemistry, chemical engineering and/or food science related subject, along with three or more years experience in the industries mentioned above.

Interested candidates should direct confidential cv to:

European Technical Centre
546 Stonefield Way
South Ruislip
Middlesex HA4 0JX

UNIVERSITY OF KENT AT CANTERBURY
Biological Laboratory

Applications are invited for the following posts funded by a grant from the Agricultural and Food Research Council to Dr R. B. Cain for a study of the regulation of the uptake and catabolism of aromatic compunds derived from lignin degradation by wood-rotting and litter fungi.

A POSTDOCTORAL
RESEARCH FELLOW

to undertake an investigation of the regulation of aromatic monomer and dimer degradation, identification of inducers and characterisation of the enzyme-catalysed steps which at present are ill-defined. Candidates should have a background in microbial biochemistry and experience in the use of chemostats, preferably with fungi. Salary range £7520-£9390.

A RESEARCH TECHNICIAN
(Grade 3)

with experience in the handling of micro-organisms to assist in the production of transport-deficient metabolic and regulatory mutants of selected fungi, identification of the genetic lesions and preparation of (^{14}C)-labelled compunds. Salary scale £5399-£6325.

Further details and application forms may be obtained from the Senior Assistant Registrar, Faculty of Natural Sciences, Chemical Laboratory, The University, Canterbury, Kent CT2 7NH to whom completed applications should be submitted by 18 December, 1984. Please quote reference A64/84/NS.

UNIVERSITY OF ESSEX
Department of Electrical Engineering Science

SENIOR RESEARCH OFFICER
Coherent Optical Fibre Systems

Applications are invited for the above post, for appointment as soon as possible, to work on an SERC funded project concerned with modelling and performance evaluation of advanced optical communication systems exploiting source coherence. The project involves both theoretical and experimental investigations. Applicants should have a relevant honours degree and preferably previous experience in communication systems studies or optical physics.

The salary will be on Range IA (£7520-£12 150 pa), according to qualifications and experience. The post will be tenable for up to three years.

Enquiries about this post may be made to Dr J. J. O'Reilly, Tel Colchester (0206) 862286, Ext 2269.

Applications (three copies), including a cv and the names and addresses of three referees, should reach the Registrar (R/219/NS), University of Essex, Wivenhoe Park, Colchester CO4 3SQ, by 28 December, 1984.

Nutritionist

for UK animal studies centre c. £19,600

The Pedigree Petfoods Animal Studies Centre, located in the attractive East Midlands countryside, is Europe's foremost centre for the study of pet animal nutrition and care. A truly international body funded by all Mars pet-care companies worldwide, it houses about 600 cats, dogs and cage-birds, and is staffed by a committed, well qualified and highly professional team.

The Centre now seeks to recruit a qualified nutritionist who is keen to practise in a challenging international environment and to further the development of a renowned centre of expertise.

Operating as part of the Centre's management and nutrition teams, you will plan, supervise and interpret studies relating to pet animals' nutrition. Working in close conjunction with our Product Development and Marketing functions, and maintaining a sound awareness of our overall commercial objectives, you will be responsible for product validation and trials, and for advising on the nutritional aspects of all Company literature. Extensive liaison with both external research institutions and our sister-companies will involve you in regular UK and European travel.

Aged 24-32, you should have gained at least three years' nutritional research experience following a degree in a relevant biological discipline. You will relish the freedom to initiate and gain acceptance for your own ideas in a recognised international centre of excellence.

The post offers wide opportunities to progress within this highly successful, market-leading company — indeed, the vacancy has arisen as the result of an internal career development move into Marketing. Salary is supported by a fully comprehensive range of benefits including generous assistance with relocation (if appropriate).

Please telephone Howell Wilson-Price, Management Development Officer, for further written information and an application form on 0664 64171, ext. 3034.

Do **not** send a cv at this stage.

Pedigree Petfoods, National Office, Waltham-on-the-Wolds, Melton Mowbray, Leicestershire LE14 4RS.

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Department of Biochemistry

University of Oxford

RESEARCH TECHNICIAN
GRADE 5
(Ref: B/T/119)

A vacancy will exist for a three year period commencing 1 January, 1985, in an active research group, involved in studies of the control of gene expression by steroid hormones. Experience of nucleic acid technology would be an advantage. Candidates should be educated to at least HNC level or equivalent. Salary on the scale £6581-£7684 pa.

Applications, including names and addresses of two referees should be sent as soon as possible to:

The Administrator
Department of Biochemistry
South Parks Road
Oxford OX1 3QU

ASSISTANT EDITOR

A leading fortnightly publication in the industrial metal-forming sector, Foundry Trade Journal is seeking an Assistant Editor. The applicant who is expected to demonstrate writing skills, should preferably have had a background in manufacturing industry and/or a relevant qualification in a technical discipline, such as metallurgy. Ideal age range is 25 to 35.

Foundry Trade Journal is published by Fuel & Metallurgical Journals Ltd., an Industrial Newspapers PLC Company. As publishers of over 50 trade and technical journals, and organisers of conferences and exhibitions there are ideal opportunities for promotion internally.

A good salary will be paid and after six months' successful probationary period a company car will be provided.

The successful candidate will be part of a team and be asked to also contribute material to the sister publications of Foundry Trade Journal International and Foundry Year Book.

Please reply in writing to: C. McCombe
Editor
Foundry Trade Journal
Queensway House
Redhill
Surrey RH1 1QS

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University of Strathclyde

Department of Bioscience and Biotechnology (Food Science Division)

RESEARCH ASSISTANT

Applications are invited for a Research Assistantship, tenable for three years, funded by the Ministry of Agriculture, Fisheries and Food, to study the properties of amylose-lipid complexes. Applicants should have an honours degree in Biochemistry, Chemistry or a related subject, and previous research experience with starch and similar polysaccharides would be an advantage.

Appointment on Range 18 (£6600-£8920 per annum). USS benefit.

Applications (quote Ref: R53/84) with full curriculum vitae and the names and addresses of three referees should be sent to Professor W. Morrison, Food Science Division, Department of Bioscience and Biotechnology, University of Strathclyde, 131 Albion Street, Glasgow G1 1SD.

Closing date for applications: 7 January, 1985.

Office of the Supervising Scientist
Alligator Rivers Region Research Institute
Jabiru, Northern Territory

GROUNDWATER CHEMIST or HYDROGEOCHEMIST

(Research Scientist/ Senior Research Scientist)

$25,342 - $37,274 p.a. (Ref. VJ 12)

The Supervising Scientist for the Alligator Rivers Region is a statutory office, established by the Environment Protection (Alligator Rivers Region) Act, 1978, responsible directly to the Minister for Home Affairs and Environment. The Supervising Scientist is responsible for coordinating and supervising activities concerned with the protection of the environment, mine workers and members of the public in the Alligator Rivers Region from the effects of uranium mining operations. The Supervising Scientist is also responsible for the research necessary to establish standards and protection measures, and for defining practical and effective programs to monitor the environmental impact of uranium mining operations.

The focus of these research activities is the Alligator Rivers Research Institute. Permanent facilities are proposed to replace a well-equipped temporary laboratory presently established near the recently constructed regional centre of Jabiru, close to the Ranger mine site.

Jabiru, though a remote township, has a growing population which currently stands at about 1250. It is located 260 km east of Darwin within the Kakadu National Park (an area included in the World Heritage List) and provides all the community facilities expected in a modern town.

Local residents of the Region have available to them pastime activities such as boating, fishing, photography, bird watching, bushwalking and studying Aboriginal art sites.

DUTIES: As required to initiate, direct and carry out research into the processes and kinetics that determine the movememt of heavy metals, radionuclides and inorganic radicals in groundwater at operating mine sites. Studies will include those of adsorption, desorption, exchange and precipitation phenomenon accompanying aqueous transport in the unsaturated zone; modelling the distribution of transported chemicals in the ground and their possible transfer to surface water; and the application of the results of such studies to the development of measures to prevent contamination of the environment.

Qualifications: Applicants should possess a PhD or equivalent qualification, plus a minimum of 5 years postdoctoral research experience in a directly relevant field such as soil physics, physical chemistry of adsorption processes, hydrogeochemistry. Mathematical modelling and computing experience is desirable.

General Conditions: The successful applicant may be appointed, if eligible, as a permanent officer of the Australian Public Service, or engaged on a fixed-term temporary arrangement. As appropriate, the successful applicant will be employed within salary scales indicated, depending on qualifications and experience.

Conditions of service include 5 weeks and 2 days annual leave, annual leave fare assistance, cumulative sick leave and district allowance. Fares and removal expenses to take up duty may be payable in some circumstances. Goverment accommodation is available at a nominal rent at Jabiru.

Contact for enquiries is Dr G. Riley on (089) 79 2300.

Applications (including curriculum vitae, nominated referees, and telephone contact number) should reach the Supervising Scientist, PO Box 387, Bondi Junction, NSW 2022, Australia, by 3 January, 1985.

AUSTRALIA

COMMONWEALTH MYCOLOGICAL INSTITUTE

SCIENTIFIC INFORMATION OFFICER

One aspect of the work of the Institute is to collect, collate and make available, through its publications and otherwise, information relating to mycology, plant pathology, medical and veterinary mycology, biodeterioration, and allied subjects from the world's literature.

Duties: The Scientific Information Officer will be concerned primarily with the production of the *Review of Medical and Veterinary Mycology*, though the successful candidate will be required to assist with other publications of the Institute as the need arises. The main duty would be all stages in the production of abstracts, including the scanning of relevant journals, writing abstracts, indexing, and proof reading. Occasional duties would include on-line retrieval from the CAB computerised database, preparation of bibliographies, and dealing with enquiries.

Qualifications: A first degree or equivalent qualification in some aspect of the biological sciences in which mycology has featured is required, together with an interest in information science. Postgraduate experience in information science would be an advantage, but is not essential. Applicants must be able to render the content of scientific articles into concise, accurate and readable abstracts. A reading knowledge of two or more languages and an ability to type would also be assets.

Salary: £0382–£10 261 pa (under review).

Applications by 21 December to the Adminstration Officer, Commonwealth Mycological Institute, Ferry Lane, Kew, Surrey TW9 3AF from whom application forms and particulars may be obtained.

UNITED MEDICAL AND DENTAL SCHOOLS OF GUY'S AND ST THOMAS'S HOSPITALS

GUY'S HOSPITAL MEDICAL SCHOOL

POSTDOCTORAL RESEARCH ASSISTANT

required until mid-1986 in the Biochemistry Department, to investigate the formation of an odorous steroid by human axillary microorganism. Applicants should be biochemists, preferably with knowledge of microbiological techniques. Initial salary not less than £7520 pa plus £1233 pa London Allowance.

Apply in writing, with curriculum vitae and the names of two referees to the Secretary, Guy's Hospital Medical School, London Bridge, London SE1 9RT, quoting Ref: G/B/09, by 20 December, 1984.

TECHNICIAN (Grade 5)

required in Department of Soil Science, soil physics section, University of Reading. Duties include operation, maintenance and development of laboratory and field equipment used to measure the physical and mechanical properties of soils. Relevant experience desirable, but applicants without it considered if they have appropriate technical skills. Salary in scale £6581 to £7684 pa. Application form available from Personnel Department, Whiteknights House, University of Reading, Whiteknights, PO Box 217, Reading, Berks RG6 2AH. Please quote Ref. T39A.

Pharmacologist

Greenford, Middlesex

Glaxo Group Research, Britain's leading pharmaceutical research organisation, has an opportunity in its Neuropharmacology Department for a pharmacologist to join a project team investigating the underlying causes and possible treatments of various mental disorders. The successful candidate will be innovative, technically able and highly motivated towards research into drug-receptor mechanisms and how drugs react with the central nervous system.

We are looking for a pharmacologist who either has 2-3 years post-graduate experience in the pharmaceutical industry working in a relevant area or has completed, or is about to complete, studies for a PhD. The project team will be moving in 1986 to join the rest of our Neuropharmacology Department in newly-modernised laboratories at our Ware Division in Hertfordshire.

The company offers excellent conditions of employment including a non-contributory pension scheme, bonus schemes, subsidised canteen and an active sports and social club.

Please send a full cv or write for an application form to: The Senior Personnel Officer (MRKK), Glaxo Group Research Ltd, Greenford Road, Greenford, Middlesex UB6 0HE, quoting reference number 557.

***Glaxo** Group Research Ltd.*

New/Recent Science Graduate

. . . for a progressive role in technical information

Hemel Hempstead

Du Pont (UK) Ltd is a subsidiary of one of the world's 10 largest companies. The Polymer Products Laboratory at Hemel Hempstead carries out work on customer-related problems and development of new uses for Du Pont products. We now require a young person to join our team of professionals providing technical support to customers throughout Europe.

After product training you will have responsibility for providing a technical information service, which will involve operating a centralised information system linked to a mainframe computer located in Wilmington, Delaware.

This is an attractive opportunity for a new or recent graduate in chemistry, materials science or physics, who has a good knowledge of database systems, to tackle an interesting and demanding job which will lay the foundations for future career development in a technical specialisation or sales role.

Previous experience in a materials science or information technology environment, while not essential, would be highly advantageous.

We offer a highly competitive salary, plus an excellent benefits package.

For further information and an application form, please write to or telephone: V. N. Chatterton, Division Head of Services, Du Pont (UK) Ltd, Maylands Avenue, Hemel Hempstead, Herts HP2 7DP. Tel: Hemel Hempstead (0442) 61251.

Young Microbiologist

"A unique opportunity to assume early responsibility in a sophisticated production environment".

As the undisputed leaders in the highly competitive DIY field, our commitment to product development and quality control is considerable – your influence within these areas will be equally important.

Reporting to the Chief Chemist, your involvement will stretch from raw material, through production to end product stage, and will entail identifying and solving all problems relating to product deterioration and decay. In short, through the design of sample testing methods and the selection of preservatives, you will set the quality standards and performance levels for our entire product range.

It's a role involving close liaison with Q.C. Production and shop floor, and one calling for high levels of credibility, initiative and innovative ability.

To succeed, you'll be aged 25-35, a Graduate Biologist or Biochemist with at least 3 years Industrial experience, preferably in a food/process environment. The rewards and career prospects are highly attractive, and what you'd expect of a progressive market leader.

Contact Mr J. Muress, Personnel Officer on (07073) 28131 or alternatively send a brief CV to me at: Polycell Products Ltd, 30 Broadwater Road, Welwyn Garden City, Herts. AL7 3AZ.

Polycell. Do it right.

Taking innovation to the extreme in electromagnetics technology

up to £15,000

At its headquarters in Southern England, this highly successful company is looking for additional Electronics Engineers to join a specialist team carrying out practical testing and theoretical analyses of the interaction of military systems and equipment with various extreme environments, including nuclear and electromagnetic radiations.

You'll be involved in a wide variety of challenging projects in both analytical and experimental areas and in applications ranging from command and control systems to guided missiles and other weapon systems.

It's a role calling for a highly creative and innovative approach to systems development and the Company is looking for men and women who can work with the minimum of supervision. You'll also need the personality and communications skills to liaise effectively with company departments, the MOD and other agencies.

A degree/HND/HNC level qualification in either physics or electronics/electrical engineering is required. Ideally, this should be coupled with experience of EMC,EMP,RF measurements, antenna design, radio communication or allied fields.

Salary will be in the range £11,000 – £15,000p.a. plus a generous benefits package including assistance with relocation to this attractive area. There are excellent opportunities for career progression in this newly formed but already well-established company.

Write with full c.v. to Confidential Reply Service, Ref. AET558 Austin Knight Advertising UK Limited, 66a High Street, Egham, Surrey TW20 9EY.

Applications are forwarded to the client concerned, therefore companies in which you are not interested should be listed in a covering letter to the Confidential Reply Supervisor.

Austin Knight Advertising

LEWISHAM AND NORTH SOUTHWARK HEALTH AUTHORITY

NATIONAL POISONS INFORMATION SERVICE

An Information Officer is required for a team providing a 24 hour telephone information service to the medical profession on the management of acute poisoning.

The successful candidate will be a graduate in biological sciences with experience or proven interest in toxicology, pharmacology, biochemistry or biomedical information science.

The post will be for a period of one year in the first instance.

Salary Scale: £5939-£6967 (Inc London Weighting) plus 20% shift work allowance.

An application form, job description and information sheet are available from the District Personnel Department on 01-407-7600 ext. 3470. Closing date: two weeks after publication.

UNIVERSITY OF CAMBRIDGE

Department of Clinical Veterinary Medicine

RESEARCH TECHNICIAN (NEUROBIOLOGY)

There is a vacancy for a research technician to form part of a group studying the biology and pathology of glial cells (particularly astrocytes) *in vitro*, in relation to repair and regeneration in the nervous system. Experience of tissue culture is essential and of immunocytochemistry would be useful. The post is established for three years and the salary scale is £6110-£7032. Further information may be obtained from Dr R. J. Evans (Tel: Cambridge (0223) 355641 Ext: 243). Applications, including CV and the names of three referees, should be sent to the Principal Assistant, University of Cambridge, Department of Clinical Veterinary Medicine, Madingley Road, Cambridge CB3 0ES.

UNIVERSITY OF MANCHESTER

Department of Chemical Pathology

RESEARCH TECHNICIAN

required to join a research group investigating hormone secretion by human lung tumours in culture. Candidates must have at least HNC and several years' laboratory experience. Proficiency in cell culture is essential and some experience with immunological techniques would be an advantage.

Salary scale £6106 to £7024 pa. The appointment is for one year in the first instance.

Further information available from Dr Anne White (061-789-7373 ext. 354).

Applications with full details of age, experience, qualifications and details of two referees to Professor J. G. Ratcliffe, Department of Chemical Pathology, Hope Hospital, Salford, M6 8HD, within two weeks of the appearance of this advertisement.

PUBLIC HEALTH LABORATORY SERVICE BOARD

PHLS Centre for Applied Microbiology & Research

PROCESS DEVELOPMENT BIOCHEMIST

A protein chemist/enzymologist is required for the development of purification processes for new therapeutic products from human pituitary glands and other sources using pharmaceutically acceptable techniques. The work will include research into methods of protein immobilisation for immunoaffinity chromatography and the development of chemical tests for biological potency.

Applicants should possess a good Honours Degree in Biochemistry/Chemistry and at least three years relevant post-graduate experience. Further information may be obtained from Dr G. W. Jack, Head of Process Development Section, TPL.

The successful applicant will be appointed as a Basic Grade Microbiologist. Salary will be in the range £6559-£8725. National Health Service terms and conditions will apply.

Applications including curriculum vitae and the names and addresses of three referees should be sent to the Personnel Officer, PHLS Centre for Applied Microbiology & Research, Porton Down, Salisbury, Wilts.

Closing date for applications 31 December, 1984. Please quote reference 29 when applying.

BARNET HEALTH AUTHORITY

BASIC GRADE PHYSIOLOGICAL MEASUREMENT TECHNICIAN

BARNET GENERAL HOSPITAL

Salary: £5490-£6852 inclusive of London Weighting.

Required to work in the Cardiac Department of this busy General Hospital. The Cardiac Department's main functions include stress tests, 24 hour ambulatory monitoring, echocardiographs and temporary pacing.

Temporary accommodation available.

Further details from Mrs De Bono, 01-440 5111 Ext 318.

For job description and application form please contact the Personnel Department, Barnet General Hospital, Wellhouse Lane, Barnet, Herts.

Telephone: 01-440 5111 Ext 450 or 01-441 4568 (24 hour answering service).

Closing Date: 20 December, 1984.

CHIEF TECHNICIAN

needed in the Department of Medicine, The Middlesex Hospital Medical School. This is a permanent UGC funded post. The Department has four Senior Academic members, five Lecturers and 11 members of technical staff. Last year the Department raised over £160 000 in soft money. We need someone young and dynamic to fill this post with experience in the cardiopulmonary field. Some experience in very basic and simple workshop and electric skills desirable.

Salary within the scale £10 407-£11 907 pa including London Allowance. Applications (cv plus names and addresses of two referees) to Professor S. J. G. Semple, Department of Medicine, 5th floor, Thorn Institute, The Middlesex Hospital Medical School, London W1P 7PN.

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Medical Posts

South Africa

Applications are invited from suitably qualified persons, regardless of sex, race, colour or national origin for appointment to the following posts at the University of the Witwatersrand in Johannesburg.

PHYSIOLOGY
JUNIOR RESEARCH OFFICER

The Junior Research Officer in the Medical Research Council/University Circulation Research Unit will be expected to participate in an on-going programme on the control of coronary blood flow in health and disease, as well as the biochemistry of autonomic receptors in the cardiovascular system.

Applicants should have at least a BSc Honours degree with a background in physiology, biology, zoology, biochemistry or veterinary science.

Applications should be made by 7 January, 1985.

MEDICINE
SENIOR LECTURER/LECTURER

The successful applicant to the position of Senior Lecturer/Lecturer in the Department of Medicine should hold a higher degree in science or a medical or veterinary qualification. A strong background in the field of Medical Biochemistry would be desirable.

The Department offers outstanding opportunities for research. The major laboratory and research interests being in the fields of iron and red cell metabolism diabetes and lipid metabolism, hepatology, nephrology, endocrinology. In the case of a registered medical practitioner arrangements can be made for remunerated part-time attachment to a clinical department for the purpose of patient care and research.

Duties include: participation in the teaching and research programmes, responsibility for supervising the department's laboratories, ensuring that adequate standards are maintained. Submit applications by 30 January, 1985.

Academic Salaries are currently under review. Details are obtainable on request.

Benefits: ● annual bonus ● generous leave ● pension ● medical aid ● remission of fees for dependants attending the University ● housing subsidy (if eligible) ● removal, travel and settling-in allowances may be payable.

For a detailed information sheet contact Mr Geoff Henning, South African Universities Office, Chichester House, 278 High Holborn, London WC1V 7HE, England.

UNIVERSITY OF THE WITWATERSRAND

UNIVERSITY OF CAMBRIDGE

RESEARCH TECHNICIAN

To work on 3yr. CRC. funded project molecular biology of the spectrin genes.
Salary £6110-£7032.
Send C.V. and names of two referees to:-
Dr C. Colaco, Dept. of Clinical Biochemistry, University of Cambridge Clinical School, Hills Road, Cambridge CB2 2QR.
By the 31 December, 1984

GRADUATE RESEARCH ASSISTANT required to work as part of a group investigating hormone dependence in hepatocellular carcinoma. Previous experience with tissue culture techniques essential. Salary will be on the MLSO scale, starting point according to qualifications and experience. Please reply with CV and names of two referees to Secretary to Director of the Liver Unit, King's College Hospital, Denmark Hill, London SE5 8RX. Closing date 7 January, 1985.

THE OPEN UNIVERSITY

Summer School Tutorial Staff

Appointments for one or two weeks are available at the Open University's summer schools held at universities throughout Great Britain between 6th July and 7th September 1985.

Tutor Posts in the Faculty of Arts
Tutors qualified in:
Art History, History, Music, Literature and Philosophy.

Tutor Posts in the Faculty of Social Sciences
D102 - Making Sense of Society.
Tutors experienced in teaching introductory level Social Science and in interdisciplinary teaching, qualified in one or more of: Economics, Human Geography, Politics, Psychology, Sociology, to teach in one of three interdisciplinary modules - Crisis and Conflict: The Fight for Shelton Bar; Mass Media and Society; Men and Women and Society.
DS262 - Introduction to Psychology
Tutors with experience of Experimental Methodology in different areas of Psychology.
D303 - Cognitive Psychology
Tutors qualified in Experimental Psychology. Computer experience desirable.

Tutor Posts in the Faculty of Mathematics
Tutors for the following courses: Mathematics: A Foundation Course (M101), Introduction to Pure Mathematics (M203), An Introduction to Calculus (MS283), Mathematical Models and Methods (MST204).

Tutor Posts in the Faculty of Science
Tutors qualified in: Biology, Chemistry (Organic, Inorganic, Physical and Photochemistry), Earth Sciences and Physics.

Tutor Posts in the Faculty of Technology
Tutors qualified in Elementary Mathematics and Modelling (for technologists) (TM282), Materials Science (T252), Systems (design, planning and management of social or technical systems), and Engineering Mechanics (Solids) (T232).
T101 - Living with Technology
Tutors having teaching experience and qualifications and/or interests in the areas of Energy Policy and Resources, Microprocessors, Water Quality (Biology or Chemistry), Materials Science/Metallurgy, Mechanical Engineering.
T281 - Basic Physical Science for Technology
Tutors qualified in general properties of matter, electricity, optics, heat and chemistry.
T283 - Introductory Electronics, and T291 - Instrumentation
Tutors qualified in Electronics and/or Instrumentation: previous teaching experience an advantage.
TAD292 - Art and Environment
Tutors to facilitate creative projects in a range of practical project-based multi-media arts.

Tutor Posts for the U-Area
U203 - Popular Culture
Tutors with teaching experience and interest in the following areas: Cultural Studies, Semiology, Film and Television Study, Sociology and Social History.
U204 - Third World Studies
Tutors with experience of teaching Third World Studies in Higher Education.
U221 - The Changing Experience of Women
Tutors with experience of teaching Women's Studies within Higher, Further or Adult Education.

Demonstrator Posts
Graduates in Science to work in areas of Biology, Chemistry, Physics, Earth Sciences. Graduates in Science and Engineering to work in areas of Materials Science, Metallurgy, Corrosion, Chemistry (water quality experiment), Electronics/Computing (microprocessor activity).
Graduates in Psychology
Graduates in Mathematics, Science or Technology with some knowledge of Dynamics.

Application Procedure
For further particulars and an application form send a postcard to the Summer School Tutors Office (SS/4), P.O. Box 82, The Open University, Milton Keynes, MK7 6AU. Completed application forms must reach the Open University by Monday 28th January 1985.

Central Toxicology Laboratory

Metabolism Chemist/Biochemist

Emphasis on new product development continuously maintains ICI's status as a leading international chemical company. New pesticides, polymers, solvents – all have to be monitored for the control of toxic hazards.

The Central Toxicology Laboratory plays a vital role in providing this service to ICI's manufacturing operations as well as supporting an active research programme to advance knowledge in assessing the toxicity of chemicals to man.

We have a vacancy in the Biochemical Toxicology Section for a person to join a group engaged on studies designed to elucidate the metabolic fate of radio-labelled pesticides. The job will involve the indentification of metabolites isolated from biological samples and will entail the use of a wide range of chemical and biochemical techniques including chromatographic and radio-chemical analyses. The successful candidate would be expected to work under minimal supervision and would be responsible for progress of the work and maintenance of detailed records in a form suitable for reporting to regulatory authorities.

We are looking for a graduate in chemistry or biochemistry with a minimum of 1-2 years experience in both chromatographic methods (particularly HPLC and GC) and the isolation and indentification of small amounts of chemicals. Knowledge of the metabolic fate of foreign compounds in mammals or experience in the use of radiochemical tracer methods would be an asset.

We are offering a starting salary of around £7750 – £8500 pa. In addition to salary we offer a generous range of benefits including profit Sharing Scheme. ICI offers the most favourable working conditions and the Laboratory has modern facilities with excellent support for scientific work. Assistance is available with relocation to this attractive part of the country.

Applicants, male of female, should telephone for an application form quoting reference MC/BT/BJ to:

The Personnel Section,
ICI Central Toxicology Laboratory,
Alderley Park, Nr Macclesfield,
Cheshire.
Tel: (0625) 582711 ext 272.

All application forms must be returned by 3rd January 1985.

ICI is an equal opportunity employer.

THE UNIVERSITY OF DUNDEE

NINEWELLS HOSPITAL AND MEDICAL SCHOOL

Cardiovascular Epidemiology Unit

RESEARCH ASSISTANT (BIOMEDICAL SCIENCE)

The Unit (Director: Prof. H. Tunstall Pedoe) is undertaking a programme of research, funded by the Scottish Home and Health Department into heart disease, its incidence and risk factors in the Scottish population. A graduate with training or experience in Biomedical Sciences is required to work in the implementation and data management of a population screening survey and to work on a number of smaller projects. The post will involve field work for which appropriate training will be given.

The appointment will be for three years in the first instance at an initial salary dependent on qualifications and experience but within the range IB £6600-£8920. Applications containing full career details and the names of three referees should be lodged by 19 December, 1984 with the Personnel Officer, University of Dundee, Dundee DD1 4HN from whom further particulars are available. Please quote Ref. EST/79/84H.

UNIVERSITY OF EDINBURGH

RESEARCH TECHNICIAN

required for the Department of Molecular Biology, Mayfield Road, to assist in an investigation of the molecular basis of hybrid dysgenesis in *Drosophila melanogaster*. Duties include the use of techniques of recombinant DNA technology and simple genetic manipulation of Drosophila. Applicants should hold SCOTEC Higher Certificate or equivalent qualification in a relevant discipline. The post is funded by the Medical Research Council until September 1986 with the possibility of extension. Salary on scale £6581-£7684. Ref. NST 420.

Further particulars, where available, and application forms, may be obtained from the Personnel Office, University of Edinburgh, 63 South Bridge, Edinburgh, EH1 1LS. Tel 031-556 2930 (24 hour answering service). Please quote reference number.

TECHNICIAN (Grade 3)

required in Food Studies (Microbiology Laboratories) University of Reading to service teaching laboratories and to assist with research. At least three years experience in microbiology or related field essential, with ONC, TEC or equivalent qualification. Salary in scale £5399-£6325 pa. Application form available from Personnel Department, Whiteknights House, University of Reading, Whiteknights, PO Box 217, Reading, Berks RG6 2AH. Please quote Ref. T38A.

UNIVERSITY OF SUSSEX

School of Biological Sciences

RESEARCH FELLOW

Applications are invited for this SERC funded postdoctoral research post to work on a project concerned with the influence of natural organic species, including short-chain carboxylic acids on the behaviour, physiology and copper uptake by snails. The successful applicant will work as a member of a team which aims to produce ingestible controlled release formulations designed to remove medically and agriculturally important snails in collaboration with industrial firms.

Experience in the techniques involved in measuring heavy metal uptake, AAS, HPLC, toxicity testing and other bioassay work would be an advantage.

The post is tenable in the first instance for eight months and is to commence as soon as possible after 1 January, 1985. Salary £7520 on the 1A Scale for Research and Analogous Faculty.

Two copies of application, including full curriculum vitae and the names of two referees should be sent to Dr J. D. Thomas, School of Biological Sciences, University of Sussex, Falmer, Brighton BN1 9QG.

NORWICH HEALTH AUTHORITY

VACANCY FOR AN AUDIOLOGICAL SCIENTIST

Required to provide a service for the conduct of audiological and vestibular investigations for adults and children at the Regional Audiology Centre at the Colman Hospital, Norwich, and to undertake combined clinics with E.N.T. Surgeons. Other clinics in East Anglia will also be visited, including twice monthly clinics at Addenbrooke's Hospital, Cambridge. Training duties are also included and there are opportunities for involvement in research. A relevant science degree with a higher degree in Audiology is required.

The appointment will be on the Basic or Senior Scientific Officer Grade according to qualifications and experience. Salary for a graduate with a 1st or 2nd class honours degree would be within the scale £6559-£8311 pa. Salary scale for a candidate with the appropriate experience to be appointed to the Senior grade is £9415-£12 173 pa.

An application form and further details can be obtained from the Personnel Officer, Norwich Health Authority, 102/104 Prince of Wales Road, Norwich, or telephone Norwich (0603) 611233. An informal visit to the Regional Audiology Centre can be arranged prior to interview.

The closing date for receipt of applications is 21 December, 1984.

School of Industrial Science

LEATHERHEAD FOOD RESEARCH ASSOCIATION FELLOW

A vacancy exists within the Biotechnology Centre for an experienced research chemist to fill the above post. The successful candidate would be located at Cranfield and the work carried out in close collaboration with the Leatherhead Food Research Association. The appointment will be for a period of three years in the first instance, and will involve work on biosensors for the food industry.

Applicants should have a proven practical record, ideally with a PhD in either analytical chemistry or biochemistry. An interest in the food industry is essential, and preference will be given to applicants with some experience of biosensors.

Salary will be in the range £7520-£9860.

For an application form and further details please contact:-

The Personnel Department, Cranfield Institute of Technology, Cranfield, Bedford MK43 0AL.
Tel: Bedford (0234) 750111, extension 3336. (ref.4040).

MARIE CURIE MEMORIAL FOUNDATION RESEARCH INSTITUTE

RESEARCH ASSISTANTS

required for groups working on 1) characterisation of viral and cellular trans-acting transcription factors and their relationship to malignant transformation and 2) molecular mechanisms of multistage epithelial carcinogenesis. Salary in research grade 1B. An honours degree in a biological science and experience in molecular biological methods are required. Applications including a CV and the names of two referees to Dr G. Currie, Marie Curie Memorial Foundation, Research Institute, The Chart, Oxted, Surrey.

Microbiologist

Greenford, Middlesex

Glaxo has been a world leader in antibiotics since it helped pioneer large-scale production of penicillin in the 1940's. Today our Chemotherapy Department undertakes the evaluation of a wide range of anti-infective agents produced by synthesis or fermentation against intact micro-organisms and enzymes responsible for bacterial resistance.

A vacancy exists in this Department for a microbiologist, with at least an upper second class honours and preferably with some experience of medical microbiology, to work on the screening and development of anti-infective agents for potential medical use.

The company offers excellent conditions of employment including a non-contributory pension scheme, bonus scheme, subsidised canteen and an active sports and social club.

Please send a full cv or write for an application form to: The Senior Personnel Officer (MRKK), Glaxo Group Research Ltd, Greenford Road, Greenford, Middlesex UB6 0HE, quoting reference number 558.

***Glaxo** Group Research Ltd.*

LUDWIG INSTITUTE FOR CANCER RESEARCH
(London Branch)

The Haddow Laboratories
Clifton Avenue, Sutton,
Surrey SM2 6PX

RESEARCH TECHNICIAN

required to work within the Clinical Oncology Group of the London Branch of the Ludwig Institute for Cancer Research. The work involves preparing bone marrow smears for immunocytochemical studies and cytology to assist in the detection of micrometastases. Initially the post will be based at Sutton, and from April 1985 at St George's Hospital, Tooting, where the clinical group will then be situated. Salary in range of £5491-£7747 pa plus £623 pa London Weighting according to experience. Applications should be in writing enclosing curriculum vitae and names and addresses of two referees to the Administrator at the above address, no later than 21 December, 1984.

ROYAL POSTGRADUATE MEDICAL SCHOOL
(University of London)

BIOCHEMIST or CHEMIST

required to conduct research into the role of Aluminium Intoxication in Chronic Renal Failure. The project is a joint investigation in the Departments of Chemical Pathology and Medicine in the Royal Postgraduate Medical School and is funded for one year in the first instance.

Salary up to £7386 pa.

Application forms and further particulars are available from the Personnel Office, Royal Postgraduate Medical School, 150 Ducane Road, London W12 0HS quoting reference DNSK/1.

Closing date: 28 December, 1984

BTL

BIOTECHNICA LIMITED

Positions in Environmental and Agricultural Biotechnology

BioTechnica Limited (BTL) is a British biotechnology company affiliated with BioTechnica International Inc of Cambridge, Massachusetts. BTL seeks to appoint scientists for the following positions.

1. **Assistant Scientists** (Three positions): to work in Agricultural Group, presently comprising seven scientists and technicians, to work on the selection and manipulation of microorganisms and the development of novel microbial-based agricultural products.

   Candidates should hold a good honours degree, and in all probability will have just completed research work for a higher degree, in microbiology or biochemistry, having a major interest in microbial physiology and biochemistry. For one position experience in microbial genetics would be an advantage.
2. **Assistant Scientist** (One position): to work on the construction of certain DNA probes and related recombinant DNA techniques. Candidates should hold a PhD with research experience in this area.
3. **Assistant Scientist** (One position): to work on the biodegradation of certain xenobiotic compounds. Candidates should hold a higher degree in relevant microbial or biochemical research topics.
4. **Research Technician** (One position): to work with the established group on microbial physiology. Candidates should preferably hold a degree in microbiology or have substantial experience in basic microbiology.

Applications in writing (by 20 December, 1984) by sending a full cv together with the names of three referees, and where possible, a day time phone number to:

Catherine Pridgeon, BioTechnica Limited, 5 Chiltern Close,
Cardiff CF4 5DL, Wales, UK.

SOUTH MANCHESTER HEALTH AUTHORITY

Withington Hospital

BASIC GRADE BIOCHEMIST

Applications are invited from candidates with a good honours degree in Biochemistry or Chemistry for the post of Basic Grade Biochemist in the Department of Chemical Pathology. The Department is responsible for the routine clinical chemistry service for Withington and Christie Hospitals, and the Radioimmunoassay Laboratory provides a regional service. The laboratories are well equipped with automatic equipment including computers. The position offers experience in all aspects of the subject. The person appointed will be encouraged to study for higher qualifications.

Application forms and job description available from the Personnel Office, Withington Hospital, Nell Lane, West Didsbury, Manchester M20 8LR. Tel: 061-447 3032/34. Shortlisted candidates only will be contacted. Closing date 2 January, 1985.

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY

Department of Physics (Optics)

POSTDOCTORAL RESEARCH

A new research programme in image processing using nonlinear optics has been established. We are seeking a postdoctoral Research Assistant with experience in photorefractive media and/or nonlinear optics to assist in this research. Salary in range £8753-£10 623 including London Allowance.

Enquiries and applications (cv and names of two referees) to Professor J. C. Dainty, Blackett Laboratory, Imperial College, London SW7 2BZ before 15 January, 1985.

Senior Information Scientist

Electro optics components involvement

ERA Technology is a long established Surrey-based company with an impressive record of innovative research and development in many fields including electro optics.

Within our Information Centre, we have created a new post for an Information Scientist, whose first and largely autonomous task will be to develop our optical sensor component directory and associated services.

The role will attract an outgoing graduate from an electrical engineering, physics or computer science background; someone who is probably now working for a professional institution, in the technical publishing world or within the information services area of a large electronics company.

The right man or woman should ideally have specific experience as an information specialist in light current work, and should be familiar with the use of computer based systems and facilities. We are naturally also looking for marked ability to talk informatively to people on technical subjects. But, more important still, this is a post which calls for commercial flair and considerable personal initiative.

You will be expected to get the electro optic information products and services off the ground within about six months. So you must be the kind of innovative person who gets up and runs with your ideas, developing proposals and implementing projects at speed.

What happens next will largely depend on your capacity to expand the scope of your job. New developments in the ERA range of activities suggest a number of career enhancing possibilities which we'll outline to you when we meet.

We are offering an excellent salary enhanced by benefits including BUPA and assistance with relocation if necessary. Please write with full c.v. to the Personnel Manager, ERA Technology Limited, Cleeve Road, Leatherhead, Surrey, KT22 7SA.

ERA TECHNOLOGY

Physicist

Health and Safety - Derby

Rolls-Royce Limited – Raynesway specialises in precision engineered products which are used by the Royal Navy.

The successful candidate will join a professional team within the Health and Safety Department which has responsibility for nuclear safety and radiological protection . The duties will offer a challenge within a stimulating environment and will be concerned with technical assessments/investigations.

Applicants, male/female, must possess an Honours degree in physics and ideally have had experience in health physics work in an industrial environment.

A highly competitive salary is offered together with an attractive employment package including assistance with relocation costs where appropriate. Prospects for career progression are excellent.

To apply either write with c.v. including details of salary expectation or telephone Keith Fisher on Derby (0332) 662441, extension 68, for an application form.

ROLLS-ROYCE LIMITED

Rolls-Royce Limited – Raynesway,
PO Box 31,
Raynesway,
Derby DE2 8BJ.

UNIVERSITY COLLEGE OF SWANSEA

Senior Research Assistant

Applications are invited for the vacancy of **Senior Research Assistant in the Department of Chemical Engineering** for work on hydraulic transport of solids and concurrent flow of gas suspensions in both vertical and horizontal pipelines, a research project funded by the SERC. Applicants should have a higher degree and the successful applicant will be expected to take part in the experimental programme as well as in assisting in the supervision of PhD students in the same field. Previous experience in the area would be advantageous.

The appointment, which will start from as soon as can be arranged, will be for one year in the first instance, renewable for a further year. The commencing salary will be on a scale up to £9390 per annum plus USS/USDPS benefits.

Further particulars and application forms (two copies) may be obtained from the Personnel Office, University College of Swansea, Singleton Park, Swansea SA2 8PP, to which office they should be returned by *Monday, February 1, 1985*.

YORKSHIRE REGIONAL HEALTH AUTHORITY

Regional Medical Physics Service

The Princess Royal Hospital, Hull

PHYSICIST/ELECTRONICS ENGINEER

Salary £5937–£7807—according to qualifications and experience—Ref PT1.

A graduate is required to join a team responsible for medical instrumentation in the Humberside area. The successful candidate will, after training, be concerned with the maintenance and development of a range of sophisticated medical equipment. Applicants should have an appropriate degree and preferably some practical experience. An opportunity will be provided to study for an MSc degree.

Further details may be obtained from Dr P. R. Bourne, Principal Physicist, telephone (0482) 701151.

Application form and job description available from and returnable to the Regional Personnel Officer, Yorkshire Regional Health Authority, Park Parade, Harrogate HG1 5AH.

Closing date: 31 December, 1984.

THE NATIONAL HOSPITALS FOR NERVOUS DISEASES

Queen Square, London WC1 3BG

MLSO—ROUTINE CHEMICAL PATHOLOGY

Applications are invited for the above post from candidates who preferably possess an HNC in Clinical Chemistry, and who are or have been recently employed in a hospital laboratory. The successful candidate will be encouraged to study for the special examination.

Informal enquiries to Miss L. Chambers (Chief MLSO, Department of Routine Chemical Pathology) Tel 01-837 3611, Ext 398.

Application forms can be obtained from the Personnel Department at the above address, Tel 01-837 3611, Ext 65.

Closing date for the return of completed applications 20 December, 1984.

Analytical Chemist

to manage the development of a leading food studies lab

mid-late 20s £19,600 + benefits

One of the UK's most advanced laboratories specialising in food analysis is based within the R&D Division of Pedigree Petfoods - established market-leaders in one of the most competitive sectors of the food industry. A highly capable analytical chemist is now sought to spearhead the continuing development of the laboratory's broad span of activities in line with future commercial and scientific needs.

With a countrywide reputation, the lab exists to provide a cost-effective analytical, method development and information service. The job of the Analytical Studies Manager combines three key areas of responsibility: (1) to mastermind the continuing development of the lab to meet the demands of the '80s and '90s, identifying and introducing the requisite skills, methodologies and equipment; (2) to manage the work of a highly qualified team in line with business needs; (3) to act as an effective external representative for the Company across a wide range of academic, statutory and commercial matters. Prospects for further management development within the R&D function or elsewhere are excellent.

Aged 24-30, you must have gained at least two years' experience as an analytical chemist in the food industry or public service. (Possession of an M Chem A or MSc (Analytical Chemistry) would be a distinct advantage). Above all, you will relish the challenge of identifying and prioritising key development needs, and of implementing your ideas effectively.

Starting salary, including bonuses, will be £19,600, and our comprehensive non-contributory benefits package will include, if appropriate, generous assistance with relocation to this attractive rural area, which offers many amenities together with a good choice of low-cost housing.

Please telephone Howell Wilson-Price, Management Development Officer, for further written information and an application form on 0664 64171, ext. 3034. Do **not** send a cv at this stage.

Pedigree Petfoods, National Office, Waltham-on-the-Wolds, Melton Mowbray, Leicestershire LE14 4RS.

Pedigree Petfoods is an equal-opportunity employer.

Pedigree Petfoods **Pedigree Chum Whiskas Kitekat Pal**

REMOTE SENSING

General Technology Systems Ltd is an international technology consultancy company. The staff, many of whom have held senior positions in government and industry, provide advice on a diverse range of advancing technologies including: remote sensing, space, telecommunications, information technology, alternative energies, technology transfer, microelectronics.

The company presently co-ordinates the UK National Remote Sensing Programme on behalf of DTI and is increasing its remote sensing activity considerably both within the UK and overseas.

We require a recent graduate, with a sound knowledge of the digital techniques and applications of remote sensing to land cover studies and maritime studies, to work as an assistant to our senior consultants. The person appointed should be able to communicate well at all levels, be prepared to travel widely within the UK and accept a high level of responsibility at an early stage.

Letter of application and full cv to: Mr N. J. Stewart, General Technology Systems Ltd, Forge House, 20 Market Place, Brentford, Middlesex TW8 8EQ. (Tel: 01-568 5871). Closing date for applications 21 December, 1984.

Northern Regional Health Authority
Regional Medical Physics Department

Basic Grade Physicist

(Trainee)

Applications are invited for the above post, the tenure of which will be two years. Applicants should possess a first or second class honours degree in Physics, Electronic/Electrical Engineering, Computer Science or other relevant scientific subject. The appointment provides an excellent opportunity for graduates wishing to make a career in Medical Physics and Bioengineering.

The Department consists of Units in the Newcastle General Hospital, the Royal Victoria Infirmary and Freeman Hospital, (comprising the Regional Centre, Newcastle) and Units in Cleveland, Sunderland, Cumbria and Durham.

Salary scale: £6559-£8311

The successful candidate (who will be required to participate in the Hospital Physicist's Association Training Scheme) will train in various Units and specialised Sections of the Department and if appropriate may undertake research.

Application form and job description are available from the **Regional Personnel Officer, Northern Regional Health Authority, Benfield Road, Walkergate, Newcastle upon Tyne, NE6 4PY, telephone Tyneside (091) 2654188 ext 3112.**

Closing date: 28 December, 1984.

Scientists

Why not enter Sales?

Salaries
£6500-£8000 Basic
+ Car + Bonus

If you want a career with a future, where you are rewarded according to your effort then consider selling. We have vacancies with major companies in pharmaceuticals, diagnostics and medical/scientific equipment throughout the U.K.

For a local interview to discuss an exciting future ring Sutcliffe Selection 0256 55955, (24 hours) 46/48 Essex Road, Basingstoke, RG21 1TB.

Sutcliffe Selection

Project Leader

-NMR Spectroscopy

up to £22,000 Sunbury-on-Thames

BP Research Centre, one of the largest and best equipped centres in Europe, provides Group companies with comprehensive research and development facilities for the support of existing business areas and for the exploitation of new business.

This key post is within the Spectroscopy Branch of the Analytical Support and Research Division. The successful candidate will be responsible for leading and managing the development and application of magnetic resonance (NMR and ESR) and other areas of molecular spectroscopy.

Candidates, aged 30-40 with a relevant PhD, will probably be established experts in NMR spectroscopy with substantial experience of both liquid and solid state techniques and their application to a wide range of physico-chemical problems. In addition, applicants should have a strong interest in other forms of spectroscopy. Several years management experience related to the development and application of spectroscopy in an industrial research environment would be an advantage.

First class benefits include non-contributory pension scheme, subsidised restaurant, on-site sports and social facilities and, where appropriate, relocation assistance.

Please telephone for an application form or write enclosing a c.v., quoting reference SR 4311, to: Anne Hendry, BP Research Centre, Chertsey Road, Sunbury-on-Thames, Middx. TW16 7LN. Tel: Sunbury-on-Thames (09327) 62028.

BP is an equal opportunity employer.

BP Research
SUNBURY-ON-THAMES

Production/Formulation Chemist

Wisbech, North Cambridgeshire

Our Pesticides Formulation and Packing Plant at Wisbech which began production ten years ago is an important part of our expanding Agriculture Division operations.

It is thriving to the point where it works continuous shifts employing between 30 and 70 people. We now want to strengthen the plant's team by appointing an ambitious, enterprising young chemist.

Reporting to the Plant Manager his or her job will cover quality control and development work, with the emphasis being on diversity and flexibility, and will include supervising staff.

To be considered, you should be aged 25-30, qualified to degree level or equivalent, and should possess a few years' relevant experience, preferably in the agro-chemical industry.

For further information and an application form, please telephone Anna Waddilove on King's Lynn (0553) 841581, ext. 25.

Hoechst

NATIONAL INSTITUTE FOR RESEARCH IN DAIRYING

Assistant Scientific Officer

required in electron microscope unit which provides service support for wide range of products in food research programme. Duties very varied but will eventually include some photography, specimen preparation and the day-to-day maintenance of two electron microscopes. Considerable scope for collaborative work with other researchers. The successful candidate will find it easy to accept responsibility and to communicate with other people. Experience of light microscopy and/or histology an advantage but not essential.

Qualifications:
At least four 'O' levels grade C including English Language and Mathematics or a Science subject. 'O' or 'A' level Chemistry particularly relevant.

Starting salary in range £3,084 (age 16) to £4,729 (age 21 or over).

Equal Opportunities Employer.

Apply by letter and CV to the Secretary, NIRD, Shinfield, Reading RG2 9AT.

Please quote reference 84/29.

UNIVERSITY OF BIRMINGHAM
Faculty of Medicine and Dentistry
Department of Immunology

A GRADUATE

with a background in physics or chemistry is required to assist in the production of radioactive compounds for therapy. The project will involve the generation of suitable isotopes, by both reactor and cyclotron irradiation, and their subsequent chelation into antibodies for tumour targeting. Postgraduate experience with radioisotope handling techniques would be an advantage.

The work, funded by the CRC will be for three years. Salary on scale £6600-£8920 with superannuation. Maximum starting salary £7520. Further details contact Dr A. T. M Vaughan on 021-472 1301, Ext 3364. Candidates should submit a letter of application and cv (three copies) by December 31, 1984 to Assistant Registrar, The Medical School, Birmingham B15 2TJ. Quote Ref RA/Imm/ATMV.

UNIVERSITY OF LEEDS
Industrial Services Ltd

ORGANIC CHEMISTRY POSTDOCTORAL RESEARCH

We are seeking application for a research post involving the synthesis of (a) thebaine and other morphinian alkaloids, and (b) radioactive compunds needed in connection with work on plant tissue cultures. The project is initially for one year, sponsored by an industrial company and under the direction of Dr R. B. Herbert. Appointment will be made on the IA Scale (£7520 to £12 150) according to age, qualifications and experience.

Please send cv, including two referees, to the Managing Director, ULIS Ltd., 181 Woodhouse Lane, Leeds LS2 3AR. Tel Leeds (0532) 454084.

ANTHONY NOLAN LABORATORIES

Require a

GRADUATE ASSISTANT

In the immunogenetics section.

The research involves study of human class III HLA markers. Biochemical and/or immunological background would be useful.

Starting salary according to experience.

CV and applications, including names of two referees to Laboratory Manager, Anthony Nolan Laboratories, St Mary Abbots Hospital, Marloes Road, London W8 5QL.

RESEARCH ASSISTANT

PPF International is a leading supplier of perfumes, flavours and food ingredients, exporting three-quarters of its output to over 70 countries. Its headquarters at Ashford, Kent is also the location for the company's research and development group.

We require a Research Assistant to join a group researching the behaviour of perfumes in products. The work will involve the study of perfumes and their ingredients in all kinds of products, e.g. laundry powders, soaps and air-fresheners. The objective is to increase the effectiveness of the products through improved perfume performance. This requires the use of established techniques and the ability to develop new analytical methods as required.

You will have a degree or equivalent in chemistry, or other relevant physical science, with experience in gas chromatography and, preferably HPLC. It is an opportunity for a highly motivated individual to begin a career with a successful and expanding company which is a member of the Unilever Group.

We offer a competitive salary depending upon qualifications and experience and company benefits are those you would expect from a large international company.

Please write, or telephone for an application form to

Mr M. Brooks
Personnel Manager
PPF International Ltd
Ashford, Kent TN24 0LT.
Tel Ashford (0233) 44568

PPF

COGNITIVE SCIENCE AND INFORMATION TECHNOLOGY

The Education and Human Development Committee of the Economic and Social Research Council invites proposals in the following areas related to its programme of work in Cognitive Science and Information Technology:

i proposals for fundamental research on the dynamics of development and communication in cognitive systems;

ii proposals for research related activity and study visits aimed at research staff development in the cognitive science aspects of advanced information technology and/or its application to Education.

Further details are available from:

Martin Kender, Economic and Social Research Council,
1 Temple Avenue, London EC4Y 0BD

ESRC ECONOMIC AND SOCIAL RESEARCH COUNCIL

Clinical Research Associate

Become an expert in Medical Communications

The frontiers of medicine are constantly being extended, thanks to improved channels of communication. Here at Lederle Laboratories, the pharmaceutical division of the international Cyanamid Organisation, there is ample evidence of our already significant contribution to the world of medicine.

To provide further support for our expanding pharmaceutical business we now have a vacancy within our Medical Department for a Clinical Research Associate based in the West Midlands. Prime responsibility will be to communicate technical and clinical information about some of our key products to both individuals and large audiences of Specialists and Clinicians. Additional responsibility will include monitoring of clinical trials and commercial support for both our existing and new products.

Applicants should be aged 24+ and be able to demonstrate a high level of commercial awareness and technical expertise. A second degree is advantageous, although exceptional first degree candidates with relevant experience will also be considered.

Applicants are sought from candidates throughout the U.K. who are prepared to base themselves in the West Midlands. Relocation expenses together with attractive terms of employment and a company car, will be offered.

Please telephone Fareham (0329) 230941 (ANSAFONE) to obtain an application form any day after 12 noon.

CYANAMID

Lederle

PESTICIDE CHEMIST

An expanding Midlands based analytical consultancy urgently requires an experienced chemist to undertake the commissioning and management of a laboratory to conduct pesticide residue analyses on soil, water and crop samples from field trials and on fresh produce.

It is expected that the successful candidate will have at least five years experience in this field, preferably within a contract laboratory environment, and should be familiar with GLC, HPLS techniques. He/she will be responsible for the supervision of other technicians, devising methodology, applying the methods to the analysis of crops, soils, etc, and producing reports suitable for submission to registration authorities and technical departments of large retail organisations.

The company envisages paying an excellent salary to the right applicant.

Applicants should write with full cv to:

M. B. Thomas, Box No: D841

PRODUCTION GRADUATE

An opportunity has arisen at our Horsham site for a science graduate seeking a progressive career on the production side of the pharmaceutical industry. Initially, the successful candidate will receive training in all aspects of production in our well equipped facilities in which we concentrate on the manufacture of solid dosage forms and products for nasal use.

Subsequent operational duties will involve projects, assignments and specific operational tasks. This work pattern is designed to ensure a growing contribution to the business and to be accompanied by an increasing knowledge of our products, processes and procedures, line management responsibility being a planned progression.

Applicants should have a degree in pharmacy, chemistry or a related discipline, be practical and demonstrate the ability to communicate both orally and in writing. They should have a desire to assume responsibility and to be active team members. A minimum of one year's industrial experience is desirable.

Ciba-Geigy Pharmaceuticals is a major force in the manufacture and marketing of pharmaceutical preparations derived from international research and local development.

We offer an attractive starting salary with good prospects and the benefits one would expect from a leading pharmaceutical company.

For further details and an application form, please apply to:

Miss S.J. Byrne, Personnel Officer, Ciba-Geigy Pharmaceuticals,
Wimblehurst Road, Horsham, West Sussex, RH12 4AB.

CIBA–GEIGY

THE UNIVERSITY OF MANCHESTER

Department of Physics

RESEARCH ASSOCIATE IN PARTICLE PHYSICS

The High Energy Physics Group at Manchester has a vacancy for a research associate to work on a photoproduction experiment using the Omega Spectrometer at CERN. The experiment will take data in 1985 to study high mass states, jets and charm. Detectors used include a Ring Image Cerenkov Counter, a fine grained photon detector and a precision system for tagging the incident photon. The successful candidate will be expected to contribute particularly to the physics analysis of the data, and will be expected to have a good honours degree together with a PhD in particle physics. Salary range pa: £7520–£9860 (Superannuation). Applications including full *curriculum vitae* and the names of two referees should be returned by 21 December, 1984 to Dr M. Ibbotson, Department of Physics, The University, Manchester M13 9PL from whom further details are available.

Cavendish Laboratory
Cambridge

RESEARCH ASSOCIATE IN MACROMOLECULAR PHYSICS

Applications are invited from suitably qualified candidates for a tenured post to be held at the Cavendish Laboratory, Cambridge with the status of Research Associate. Research will be in the area of macromolecular and colloid physics, with particular reference to food physics.

The position is part of a new expanding programme within the Cavendish Laboratory, funded by the Agricultural and Food Research Council, and linked to complementary programmes in the Food Research Institute, Norwich. Salary is linked to AFRC gradings.

Candidates should have at least two years' relevant post-qualifying experience (preferably with a PhD). At least four years' postgraduate experience is required for appointment at the higher level. Salary scales: HSO £7149-£9561 (under review), SSO £8970-£11 476 (under review).

The AFRC is an equal opportunities employer.

Applications, including a CV and the names of two referees, should be addressed to The Secretary, Cavendish Laboratory, Madingley Road, Cambridge CB3 0HE to reach him before 15 January, 1985.

UNIVERSITY OF DURHAM

Department of Applied Physics and Electronics

LECTURESHIP IN ELECTRONICS

Applications are invited for a LECTURESHIP IN ELECTRONICS, tenable from as soon as possible. This permanent post is associated with the SERC initiative on VLSI fabrication and design. Teaching duties will primarily be involved with the industrially oriented MEng. (Microelectronics Option). The successful candidate will be expected to pursue research work in electronics, for which there are particularly good facilities in the following areas:

Practical VLSI design which is supported by SERC with access to their chip fabrication facilities.

Digital signal processing and data communications with emphasis on VLSI implementation.

Silicon microelectronic devices for which there is a prototype production facility in the Department.

Applicants with experience of these or other areas of electronics, electronic engineering or physics will be considered.

Salary on the lecturer scale £7520-£14 925 with superannuation.

Applications (three copies) naming three referees should be sent by 11 January, 1985 to the Registrar, Science Laboratories, South Road, Durham DH1 3LE, from whom further particulars may be obtained.

UNIVERSITY OF OXFORD

Department of Theoretical Physics

in association with St Hilda's College
or University College

University Lectureship in Theoretical Physics

Applications are invited for a University Lectureship in Theoretical Physics. It is intended that this appointment should be held in conjunction with a tutorial fellowship at a college. The University has decided that priority in this case should be given to St Hilda's College, which, however, under its statutes may admit women fellows only. Accordingly, if a woman is appointed she may be offered a fellowship by St Hilda's College. If a man is appointed, he may be offered a fellowship by University College. Separate application need not be made for the college appointment. Further particulars of the lectureship and of the college fellowships may be obtained from Professor R. J. Elliott, FRS, Department of Theoretical Physics, 1 Keble Road, Oxford OX1 3NP, to whom a *curriculum vitae* and the names of three referees should be submitted by 31 January, 1985.

ST MARY'S HOSPITAL MEDICAL SCHOOL
(University of London)

Norfolk Place, London W2 1PG

DEPARTMENT OF PHARMACOLOGY

JUNIOR B MLSO/MLSO required to assist research team working on aspects of the toxicology of flavour and fragrance chemicals, to carry out a variety of general laboratory work. Experience in the use of radioisotopes and/or HPLC would be an advantage, but training will be given. The post is available immediately and is for one year. Salary according to experience: Junior B MLSO £3612-£5036 pa + £1042 pa London Allowance. MLSO £5738-£8096 pa + £1042 pa London Allowance. Applications to Assistant Secretary (Personnel) at above address by 21 December, 1984.

Synchrotron Radiation Research

Instrumentation

The Daresbury Laboratory, situated in North Cheshire, operates major national facilities for fundamental and applied research in a wide range of sciences.

The Laboratory, in collaboration with the Medical Research Council, is expanding its work in the field of fast detectors and has vacancies for:

Physicist (Ref DL/886)

To participate in the development of multiwire proportional chambers and other x-ray imaging devices, particularly for x-ray scattering and diffraction applications to biological materials. Extension of these developments to other areas of research (e.g. atomic and molecular physics) is envisaged.

The work will entail analysis of detection processes and participation in the design and creation of detector systems in close cooperation with engineers and technical specialists.

Continuous interaction with the synchrotron radiation user community and active participation in the scientific exploitation of the devices that will emerge from this project is expected of the successful applicant.

Experience with multiwire detectors is desirable but not essential for applicants who can demonstrate an aptitude for problem solving in instrumentation for research and an ability to combine scientific principles and engineering techniques in the production of high reliability systems.

Applicants should have a good honours degree or equivalent. Some relevant experience in a research environment would be an advantage.

Physicist/Electronic Engineer (Ref DL/887)

With a primary commitment to instrumentation to assist in the development of special purpose detector systems and their application to a wide variety of experiments.

Applicants should have a good honours degree (or equivalent qualification) in physics/electronic engineering. Specialised experience in multiwire proportional detectors is desirable though not essential, but a keen interest in high speed analogue and digital signal processing is required.

The post entails working in a multidisciplinary environment and demands qualities of resourcefulness and adaptability.

The appointments for both posts will be made in the grade of Scientific Officer or Higher Scientific Officer or Professional and Technology Officer 3/2 according to qualifications and experience on a salary range of £5,909 to £10,165 per annum.

Appointments to each post allow for a non-contributory superannuation scheme and generous leave allowance. There is also a flexible working hours scheme in operation at the Laboratory.

CLOSING DATE: 20th December 1984.

Further information on these posts may be obtained from Mr. J. S. Worgan on Warrington (0925) 65000, Ext. 225.

Application forms may be obtained from and should be returned quoting the appropriate reference number to: The Personnel Officer, Daresbury Laboratory, Science & Engineering Research Council, Daresbury, Warrington, Cheshire, WA4 4AD.

We are an equal opportunity employer.

Daresbury
SCIENCE & ENGINEERING
RESEARCH COUNCIL

TECHNICAL WRITER

Medical Education Services (MES) is part of the MEDICINE Group, international publishers of clinical journals and a wide range of educational material for the medical profession. We are now looking for a third Technical Writer.

You must be able to write clear, concise, accurate and readable copy in English. You will be responsible for writing and editorial work on a variety of publications including original reports, booklets, papers and conference summaries. Deadlines are tight and a high standard is expected. You must be enthusiastic, hardworking, and prepared to travel.

Previous experience of scientific writing and editing is essential and you should have a good working knowledge of at least one of the following: biology, immunology, physiology, biochemistry, pharmacology, pharmacy.

There will be a good salary for the right applicant. Send a brief curriculum vitae and examples of written work to:

Dr G. A. B. Shelton,
Medical Education Services Limited,
Pembroke House,
36/37 Pembroke Street,
Oxford OX1 1BL

Medical
Education
Services

Registering Medical Products Worldwide

Roussel Laboratories, one of the leading pharmaceutical companies in the UK, is part of a large group actively researching, developing, manufacturing and marketing ethical pharmaceuticals.

The worldwide distribution of these products could not be undertaken without their prior registration… a vital task of the Registration Department within our Denham-based Medical Division.

We are currently seeking a Registration Assistant to assist in obtaining and maintaining the registration of all our products in the UK and in the other countries in which we operate.

In your early 20s, with a degree in pharmacology, physiology, biochemistry or pharmacy, you must be well-organised and methodical, and possess a keen eye for detail. The ability to handle and summarise scientific data clearly and concisely is very important. If you have experience in the pharmaceutical industry (ideally in registration) so much the better, but it is not essential as full training will be provided.

An excellent salary will be negotiated and the first-class range of benefits we provide includes free medical, life and sickness assurance, free family BUPA, free restaurant, contributory pension scheme, and relocation assistance where appropriate.

For an application form, please contact Mrs E Bedford, Roussel Laboratories Limited, Broadwater Park, North Orbital Road, Uxbridge, Middlesex UB9 5HP. Telephone: 0895 834343.

ROUSSEL

ROYAL HOLLOWAY AND BEDFORD COLLEGES

Biochemistry Department

Laboratory Technician Grade 3 required for research and general duties. A knowledge of animal biochemistry would be useful, but not essential.
Salary scale £5899–£6825

Physics Department

Mechanical Workshop Technician Grade 4 required for the construction and modification of apparatus using standard workshop equipment.
Salary scale £6606–£7524

Zoology Department

Laboratory Technician Grade 3 required for research and general duties. Experience of radioactive tracers an advantage but not essential.
Salary scale £5899–£6825

All these posts are based at Egham.

Applications giving details of age, experience and qualifications together with the names and addresses of two referees should be sent to Mrs D. J. Odds, Personnel Officer, Royal Holloway and Bedford College, Egham Hill, Egham, Surrey TW20 0EX.

THE UNIVERSITY OF ASTON IN BIRMINGHAM

Nowhere is the pioneering, innovative approach more apparent than at Aston University — one of the country's leading technological Universities. We are building upon an already considerable record of sustained achievement and developing new initiatives in teaching, scholarship and research. Such developments demand the highest standards and afford demanding challenges and major opportunities for outstanding individuals. If you can meet these challenges — we would like to hear from you!

"NEW BLOOD" LECTURESHIP

Department of Vision Sciences

A vision scientist, preferably with an interest in eye movement, is sought to join a multi-disciplinary team of researchers and clinicians in the Department's Clinical Neurophysiology Unit. The appointee will be involved on theoretical, physiological and ophthalmological studies, and will be expected to contribute to the undergraduate honours degree course in ophthalmic optics, which is currently attended by one-third of the UK's undergraduates in this field.

We seek a young person, with an exceptional record of research and publication in vision sciences generally and the ability to work in a creative group of colleagues on research, teaching and the development of new techniques for clinical investigation.

(REF. 650/32)

"NEW BLOOD" LECTURESHIP

Department of Mechanical & Production Engineering

The adoption by industry of new technology is rapidly changing the job of the Mechanical Engineer, and skills in the application of microprocessors are in great demand. At Aston, a small team in the Mechanical and Production Engineering Department has been developing a strong base in the microprocessor control of electrohydraulic and electrically powered actuating mechanisms, with data collected from sensors ranging from position measurement through ultrasonic detectors to video camera displays. The applications have included wood-grading equipment, the control of free ranging-vehicles, the control of attachments to agricultural machinery, and the improved control of mining machinery.

The lecturer appointed to the "new blood" post will either extend the work to the control of high-speed machinery or will develop microprocessor based identification techniques for control systems.

The work requires ability in the application of electronics, the design of mechanisms and the writing of computer software. The successful applicant, who would have a good degree in a suitable engineering, science or mathematical discipline, would be expected to have sound experience of one, and preferably more, of these fields, together with a strong interest in developing skills in the others.

(REF. 651/32)

LECTURESHIPS

Department of Pharmaceutical Sciences

Division of Pharmaceutics and Pharmaceutical Chemistry

Applications are sought for two posts from candidates with an excellent primary qualification in pharmaceutical or physico-chemical sciences and who have recently completed, or soon will complete, a PhD degree:

1. "New Blood" Lectureship in Drug Delivery System Design

(REF. 652/32)

2. Lectureship in Pharmaceutics *(REF. 653/32)*

The Department has annual recurrent funding from external sources in excess of £600K and considerable resources will be mobilised to support these posts.

If appointed, you will be expected to collaborate with members of the Drug Development Research Group and initiate original projects within the areas of advanced drug delivery system design, physical pharmaceutics or formulation development. Your application will be especially welcome if you have the motivation to make a research impact in the pharmaceutical development of the novel moieties and therapeutic strategies engendered by recent advances in molecular biology and genetic technology.

Appointments will be for a period of three years with the possibility of renewal or transfer to a continuing appointment. Salaries will be within, and may be up to the maximum of, the range £7,520 to £14,925 per annum.

If you have the qualities and expertise for these posts, write or telephone for further information and an application form (quoting appropriate job reference number), to:

Personnel Officer (Academic Staff), University of Aston in Birmingham, Gosta Green, Birmingham B4 7ET. Tel: 021-359 3611 (Ext. 4564).

Closing date for receipt of applications: 18th January, 1985.

GET THAT JOB!

A professionally prepared cv could secure you that vital interview.

Details from Dane Services 0727-66002.

CHRISTMAS—

NEW SCIENTIST

Would advertisers please note that *New Scientist* will not be published on **Thursday 27 December.** Instead there will be a special double issue on the **20 December.**

COVENTRY (LANCHESTER) POYTECHNIC

Faculty of Applied Science

Department of Applied Physical Sciences

RESEARCH ASSISTANT
£5910-£7734

required to undertake research work on one of the following projects:

Polymer Research/Rubbers in Engineering
Langmuir-Blodgett Films for Microelectronics

The appointment is available from 1 January, 1985 initially for one year with a possible extension until 30 September, 1987.

SERC RESEARCH STUDENT

For a project concerning Polymer Physical Chemistry/Mechanical Engineering. This Studentship is available for three years.

Candidates for both positions should hold a degree (or equivalent) on one of the physical sciences or engineering or have relevant industrial/research experience.

Telephone enquiries to Mr P. V. O'Connor (0203) 24166, Ext 375, quoting reference R. Application forms are available from Personnel Officer, Coventry (Lanchester) Polytechnic, Priory Street, Coventry CV1 5FB. (Please enclose a large self addressed envelope.) Closing date for applications Friday 14 December, 1984.

An equal opportunity employer

UNIVERSITY OF LONDON GOLDSMITHS' COLLEGE

Department of Life Sciences

BIOCHEMISTRY TECHNICIAN

Applications are invited for a Biochemical Technician (Grade 5) to work in the Department of Life Sciences, based within the Chemical Laboratories. The post will involve servicing a number of undergraduate courses. It is expected that the person appointed will develop expertise to support biochemical work at both undergraduate and postgraduate levels.

Experience in one (or more) of the following areas would be an advantage: NMR, liquid chromatography, or microcomputing.

City and Guilds Advanced or equivalent plus at least five years' relevant full-time experience essential.

Salary on the scale £7832 × 5 increments to £8936 inclusive of London Allowance.

Write for further details to the Personnel Officer, University of London Goldsmiths' College, New Cross, London SE14 6NW. Closing date for receipt of applications 21 December, 1984.

UNIVERSITY OF DUNDEE

Department of Biological Sciences

POSTDOCTORAL RESEARCH ASSISTANT

required to join a project on the growth, physiology and biochemistry of microalgae. Applicants should have experience in algal, bacterial, or plant physiology/biochemistry and/or use of fermenters.

The appointment will be for one year in the first instance on the R & A IA scale within the range £7520-£8920.

Send cv and names of two referees as soon as possible to the Personnel Officer, The University, Dundee DD1 4HN quoting reference EST/67/84 (H).

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BSRA

PROJECT LEADER
NOISE AND VIBRATION

c £12 000 **North East**

We are a leading independent R & D and consultancy organisation for the British marine industries employing 260 people at our Tyneside site who carry out a mixed programme of consultancy contracts and basic R & D for clients, both within the UK and overseas.

We are looking for someone to act as a Project Leader in our Vibration, Noise and Structures Department to lead a team and undertake work related to the vibration and noise associated with marine structures. The person we are looking for will probably be between 28 and 35, have an honours degree in Physics, Mechanical Engineering or Naval Architecture and should have experience of experimental techniques and familiarity with data acquisition and analysis instrumentation—preferably including laser doppler techniques for the measurement of flow. As much of the experimental work will take place on board ship a knowledge of ship structures and ship operation is desirable.

The work will be stimulating but demanding and there will be plenty of opportunity for worldwide travel, although home based. Apart from a competitive salary, other benefits include free lunches and a generous relocation package if required.

If you would like an application form and more information about BSRA please contact:-

Cathy Fish, Personnel Assistant,
BSRA, Wallsend Research Station,
Wallsend, Tyne & Wear, NE28 6UY.
Tel: 0632 625242
Please quote Ref: 84/22

UNIVERSITY OF ST ANDREWS
Department of Anatomy and Experimental Pathology

Applications are invited for the post of

LECTURER

tenable for five years in the first instance in the Department of Anatomy and Experimental Pathology. The successful applicant will be especially concerned with the

RADIOBIOLOGY

component of an MSc course in Radiation Biophysics which is organised in collaboration with the Department of Physics but will be expected also to contribute to the courses in Experimental Pathology and related subjects which the department provides for science students and for preclinical medical students.

The current research of the department includes studies of radiation-induced leukaemia, the regulation of haematopoiesis, the properties of haematopoietic stem cells and the dissemination of tumours. Candidates for this post who require further information or who may wish to visit the department are invited to communicate with Dr A. C. Riches.

The starting salary at appropriate point within range £7520–£14 925 per annum according to age and experience, plus USS.

Applications (two copies preferably in typescript) with the names of three referees should be sent to the Establishments Officer, The University, College Gate, St Andrews, Fife, to arrive not later than 8 January, 1985.

WEST LAMBETH HEALTH AUTHORITY
ST THOMAS' HOSPITAL, LONDON SEI

TECHNICIAN FOR HEART/LUNG UNIT

Technician required for the Heart Lung Unit, St Thomas' Hospital, London SEI.

Training will be given to suitable applicants who must have gained 4 GCE 'O' levels and be prepared to study for a Higher Qualification.

The main duty is to operate a Heart/Lung Machine during Open Heart Surgery.

Salary on Junior Medical Physics Technician Scale: (£3787–£4903 per annum plus £1042 London Weighting Allowance).

For application form and job description please contact the Personnel Department, St Thomas' Hospital, London SE1, Telephone: 01-928-9292 Ext 2779.

SENIOR FISHERIES OBSERVER

FALKLAND ISLANDS

Background and Duties: Based in Port Stanley, he will be the leader of a three-man team, monitoring the exploratory fishing operation of two Japanese trawlers off the Falkland Islands, with the objective of assessing the fisheries resources. One observer will be appointed to each trawler. The Senior Observer will be responsible to the Falkland Islands Government for supervising the work of the Observers; assembling, processing and interpreting the data and material collected by the Observers; and for preparing a final report for the Falkland Islands Government on the results of the survey. The appointee may be required to function as an observer at sea.

Qualifications: Applicants should be British Citizens, ideally aged 30-45 and must be experienced and professional fisheries biologists, competent in computer techniques applicable to the storage and processing of fisheries data (Apricot X1). The post is not suitable for a married accompanied candidate.

Appointment: Two years. Salary in the range £13,525 - £15,825 including an element in lieu of superannuation which will be abated if ODA is able to continue payment into candidates' existing scheme. Plus a variable tax free foreign service allowance in the range £1,110 £2,735 per annum. Should the Senior Observer be required to function as an observer at sea, he will instead receive a sea going allowance of £57 per day.

In addition to basic salary and overseas allowances, other benefits include, paid leave, free accommodation and medical attention.

For application form please apply ***quoting reference AH356/M/DF*** giving details of qualifications and experience to:

Appointments Officer,
Overseas Development
Administration,
Room AH351,
Abercrombie House,
Eaglesham Road,
EAST KILBRIDE,
Glasgow G75 8EA.

ODA

OVERSEAS DEVELOPMENT BRITAIN HELPING NATIONS TO HELP THEMSELVES

INSTITUTE OF OCCUPATIONAL MEDICINE

MINERALOGIST
DATA-ANALYST/PROGRAMMERS (3)
and IMMUNOLOGIST

This multi-disciplinary research institute wishes to appoint five scientists to assist with research and contract work. The appointments will be for three years and may provide opportunities for study towards postgraduate degrees.

Applicants should hold a degree or equivalent qualification in the appropriate discipline. Salary scale of these posts is in the range £6983 to £10 626, depending on age, experience and qualifications.

For further information and an application form, please write to Mr G. G. Hadden, Institute of Occupational Medicine, Roxburgh Place, Edinburgh, stating the post in which you are interested. Closing date will be 17 December, 1984.

Research Assistant—Grade 1B/1A
Biotechnology Unit, Leeds University

A Research Assistant is required to work on the development of assay systems for various biochemical/chemical processes. He/she should have a good first degree in biochemistry and postgraduate experience in the development of enzyme assays for biochemical processes using a variety of measurement techniques.

The post will be for a fixed term of two years, and the starting salary will be up to £7980 on salary 1B/1A.

Starting date as soon as possible—apply with full cv to:

Dr J. R. Woodward
Director of Biotechnology
LEEDS UNIVERSITY
Leeds LS2 9JT

from whom further particulars may be obtained if required.

Biochemist

for Cardiovascular Research into Ischaemic Heart Disease

Expansion being undertaken by the Boots Company in Nottingham has created a new position for an experienced Biochemist who will join the Cardiovascular group actively researching into Hypertension and Ischaemic Heart Disease.

Whilst providing biochemical support to the Cardiovascular area as a whole, the successful applicant will be required to explore and develop biochemical approaches to the treatment of Ischaemic Heart Disease in particular.

Applicants must have post graduate or post doctoral experience in biochemistry and demonstrate an appreciation of cardiovascular physiology/pharmacology. Although experience in the pharmaceutical industry would be an advantage, relevant personal expertise and the potential to lead and motivate others is more important.

Benefits are those expected of a successful Company with Profit sharing and staff discount schemes. Generous relocation to the area is available if applicable.

Application forms may be obtained from Mr. T.W. Flower,
Employment Manager (Technical), Employment Services
The Boots Company PLC, Station Street, Nottingham.
Tel: Nottingham 506255, ext. 243.

The Boots Company PLC

MRC CLINICAL RESEARCH CENTRE
(NORTHWICK PARK HOSPITAL)
WATFORD ROAD, HARROW
MIDDX HA1 3UJ

TECHNICIAN

A Technician is required to join a group engaged in the characterisation of collagen protein metabolism and gene abnormalities in connective tissue diseases. The techniques involved include cell culture, protein gel electrophoresis, restriction enzyme mapping and Northern blotting.

Applicants should be qualified to HNC or scientific degree level with previous experience with recombinant DNA techniques an advantage.

Salary will be within the range £6381-£8719 (inclusive of London Weighting) depending on age and experience.

Application forms and further details may be obtained by writing to Miss B. A. Shaw, Personnel Section, quoting reference 111/2/4319.

Closing date for applications 31 December, 1984.

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY

Department of Pure and Applied Biology

RESEARCH ASSISTANT

Applications are invited from honours graduates with some background in immunology and/or molecular biology for a three year project funded by Wellcome Trust. The study involves the development of cloned DNA and monoclonal antibody probes for differentiation of the human hydatid disease organism, *Echinococcus granulosus* (a tapeworm parasite).

Salary within scale £6600-£8920 plus £1233 London Allowance; the post is available immediately.

Please apply enclosing a cv and the names of two referees to Dr D. P. McManus, Department of Pure and Applied Biology, Imperial College, Prince Consort Road, London SW7 2BB.

CLARENDON LABORATORY UNIVERSITY OF OXFORD

Materials Preparation Group

A post will be available from 1 January 1985 for a post-doctoral Research Assistant to work on the preparation, purification and crystal growth of materials for solid state research. Preferred candidates will have had experience of preparative inorganic chemistry and/or growth of single crystals from melts.

An appointment will be made on the Research 1A scale of (£7,520-£12,150 p.a. with membership of USS) at a starting point dependent on the candidate's age and experience.

The post is supported by a rolling grant form the Science and Engineering Research Council until 31 July, 1986. The Materials Preparation Group has been funded since 1966.

Applications which should include a c.v. and the names of two referees, should be sent as soon as possible to **Dr. G. Garton, Clarendon Laboratory, Parks Road, Oxford, OX1 3PU,** from whom further information can be obtained.

RAYNE INSTITUTE
ST THOMAS' HOSPITAL
LONDON SE1 7EH

MEDICAL LABORATORY SCIENTIFIC OFFICER HISTOLOGY

This post is suitable for a candidate experienced in routine histological procedures who would like to obtain experience in a research environment. Duties will mainly be concerned with the histological preparation of osteochondral and fibrocartilage grafts, as well as studies of various aspects of fracture repair. Experience of decalcified bone material will therefore be expected, as will state registration. The post offers considerable scope for a suitable candidate to develop or apply new preparative techniques for light microscopy of bone and cartilage tissues. Opportunities for learning prefusion techniques and other aspects of surgical research will also be made available.

The post is available for one year in the first instance with a possibility of a further extension to three years.

Salary on the Basic MLSO scale is £6780-£9138 inclusive of London Weighting allowance.

For application form and job description contact the Personnel Department on 01-928 9292, ext 2422.

Closing date for completed application forms: 19 December, 1984.

QUEEN MARY COLLEGE
(University of London)

School of Biological Sciences

GRADE 4 TECHNICIAN
(Salary £7356-£8274 pa inclusive of London Weighting).

To work mainly in the Physiology Group preparing practicals for undergraduate teaching and assisting academic staff with their research. Some experience with electrophysiological equipment would be useful. HNC or equivalent with 7-9 years experience.

GRADE 2 TECHNICIAN
(Salary £6136-£6799 pa inclusive of London Weighting).

Temporary appointment for a period of one year in the first instance.

The work is to service Biochemistry undergraduate practicals and give assistance with academic staff research. Sound education and one year's experience necessary.

Applications with full cv (together with the names of two referees) stating which post applied for to be sent to Miss K. M. Garner, Personnel Assistant.

Closing date 13 December, 1984.

UNIVERSITY OF SALFORD

Department of Aeronautical and Mechanical Engineering

RESEARCH ASSISTANT

Applications are invited for the post of Research Assistant on a Ministry of Defence funded study of the structure and properties of ion plated surfaces.

Candidates should have either a PhD or a good honours degree with appropriate post graduate experience. The applicant's research interests and experience should be in the field of Materials Science, and experience of the use of advanced physical analysis techniques would be an advantage.

Salary in the range £6600 to £8450 pa, depending on age, qualifications and experience.

Application forms obtainable from the Registrar, University of Salford, Salford M5 4WT, (061 736 5843, Ext 215) to whom completed applications should be returned by 21 December, 1984 quoting reference ME/392.

Informal enquiries can be made to Dr R. D. Arnell, Ext 7422.

THE LONDON HOSPITAL MEDICAL COLLEGE
(University of London)

RESEARCH ASSISTANT IN MOLECULAR BIOLOGY
Bone & Joint Research Unit

Applications are invited for a Research Assistant to study the molecular biology of the HLA associated susceptibility gene and gene product in Coeliac Disease. Previous practical experience with cDNA hybridisation or related techniques is essential. A working knowledge of protein chemistry immunology and/or tissue culture is desirable. Part of the project will be carried out in the molecular biology laboratories of the Department of Immunology which is conducting similar studies in other diseases.

The work is funded by a 20 month grant from The Wellcome Trust. Salary £7520-£7980 plus £1233 London Weighting. (Maximum age 31 years).

Application forms obtainable from the Assistant Secretary (Personnel), The London Hospital Mecical College, Turner Street, London E1 2AD Tel 01-377-8800 Ext 12/13, and which should be returned within 21 days of this advertisement.

Clinical Research Scientist

Greenford, Middlesex

Glaxo is one of the world's leading healthcare companies, with particular interests in ethical and proprietary pharmaceuticals. Our breadth of interests is reflected in the wide selection of products at present tested in the Human Pharmacology Department, which designs, carries out and analyses pharmacokinetic and pharmacodynamic studies in healthy volunteers. Compounds under test range from new chemical entities to generics, from injectables to topicals.

The Department consists of medically and scientifically qualified staff. An opportunity exists for a PhD scientist to contribute to the work of this highly-motivated team. The responsibilities include statistical, computer and pharmacokinetic analysis, report writing, literature review for methodology and pharmacological action of drugs, presentation of information to scientific audiences and attendance at scientific meetings.

A PhD in pharmacology, pharmacy or related discipline is necessary. Experience in the pharmaceutical industry is not a prerequisite as appropriate training will be provided. A pleasant personality is essential to interact with the many groups of scientists involved in the clinical development of new drugs and the successful applicant must be both literate and numerate. It is anticipated that the post will appeal to candidates in their mid to late 20s.

The company offers excellent conditions of employment including a non-contributory pension scheme, bonus schemes, subsidised canteen, and an active sports and social club.

Please send a full cv or write for an application form to: The Senior Personnel Officer (MRKK), Glaxo Group Research Ltd., Greenford Road, Greenford, Middlesex UB6 0HE, quoting reference number 560.

***Glaxo** Group Research Ltd.*

REMOTE SENSING POSTGRADUATE ROME, ITALY

A vacancy exists within a team contracted to the European Space Agency's, Earthnet Programme Office, situated in Frascati (Italy).

The team is involved in all aspects of image quality control, but the successful candidate will be expected to provide expertise in the field of synthetic aperture radar in anticipation of the launch of the first European Remote Sensing Satellite ERS-1.

Qualifications/expertise:

All applicants should have either an MSc or PhD in a related subject, or be a graduate with several years experience in SAR processing.

Salary/conditions:

In addition to the benefits of the Italian climate and the opportunity to be involved in Europe's first Earth Resources Satellite Programme, the successful candidate can expect a salary in the range £16 000 to £20 000.

Frascati is situated some 20km from Rome and is in the centre of the famous wine growing region.

Relocation expenses will be paid and the company provides a private medical scheme for staff and their families whilst employed in Italy.

Please apply to (including cv and current remuneration):

Mr A. Pickersgill, Tecnodata Italia SRL, c/o European Space Agency, Esrin, Via Galileo Galilei, 00044 Frascati, Rome, Italy

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SOFTWARE & HARDWARE DESIGN

£8,000-£20,000
PLUS GENEROUS RELOCATION

DORSET, HAMPSHIRE, SUSSEX SOMERSET & WILTSHIRE

If you can offer Phd. or M.Sc. or B.Sc. or HNC/D in Electronics, Physics or Mathematics with a minimum of one years experience either in Software or Hardware Design we would like to discuss stimulating design career opportunities in...

C3, SATELLITE & MILITARY COMMUNICATIONS, RADAR, SONAR, AVIONICS, ATE, CAD, DATA COMMUNICATIONS etc.

SOFTWARE DESIGNERS

PDP or VAX or HP or DG or GEC experience needed or 8085/86/88 or Z80 or 6800 or 1802 experience using one or more of CORAL, PASCAL, ADA, ASSEMBLER, FORTRAN, RTL2, PLM, ALGOL, C or MACRO...

HARDWARE DESIGNERS

Sound Digital and or/analogue experience please -some microprocessor knowledge is advantageous.

WE ALSO WISH TO RECRUIT

MATHEMATICIANS, MATHEMATICAL MODELLERS, TRIALS ENGINEERS, QUALITY ASSURANCE ENGINEERS, OPERATIONAL RESEARCHISTS, RF & MICROWAVE DESIGN ENGINEERS...

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CBS APPOINTMENTS
1 Wootton Gardens, Bournemouth
0202 – 292155 (24 hours answering)
Evenings 04254 – 70379 (Agy)

Central Toxicology Laboratory

Emphasis on new product development continuously maintains ICI's status as a leading international chemical company. New pesticides, polymers, solvents – all have to be monitored for the control of toxic hazards.

The Central Toxicology Laboratory plays a vital role in providing this service to ICI's manufacturing operations as well as supporting an active research programme to advance knowledge in assessing the toxicity of chemicals to man.

Senior Dispensary Assistant

We have a vacancy in the Analytical Chemistry Section for a young man or woman to assist the Work Group leader in a busy function involved in the receipt, registration, storage, formulation and issuing of Test Substances on behalf of the whole laboratory. The efficiency of the service, and the accuracy of recording transactions is vital to the smooth running and integrity of major toxicology studies throughout the laboratory.

The job will be split equally between laboratory and administrative duties (e.g. registering compounds onto the computer system and answering technical queries associated with Test Substances). There are opportunities for development resulting from taking on additional responsibilities from the Work Group leader. Extensive on the job training will be provided.

A minimum qualification of HNC (or equivalent) in Chemistry and at least 2 years experience in laboratory work is absolutely necessary for this position. The ability to work safely and accurately under pressure to Good Laboratory Practice requirements and to deal effectively with a wide cross-section of laboratory and Divisional staff is essential. The job holder must be prepared to work flexibly, involving occasional weekend work (1 morning per weekend). Experience in formulation procedures and ability to co-ordinate and guide junior staff is desirable. Familiarity with computerised data input systems and their administration and experience of the administration of product documentation would be an asset.

We are offering a starting salary of around £7500-£7750 pa. In addition to salary we offer a generous range of benefits including profit sharing scheme. ICI offers the most favourable working conditions and the Laboratory has modern facilities with excellent support for scientific work. Assistance is available with relocation to this attractive part of the country.

Please telephone for an application form quoting the reference SDA/AC/PW to:

The Personnel Section,
ICI Central Toxicology Laboratory,
Alderley Park, Nr Macclesfield,
Cheshire.
Tel: (0625) 582711 ext 272.

All application forms must be returned by 3rd January 1985.

ICI is an equal opportunity employer.

THE CENTRAL BLOOD LABORATORIES AUTHORITY

has vacancies for two

Graduate Research Technicians

in the

Research and Development Department
Blood Products Laboratory
Elstree, Herts

Applications are invited from graduates with an honours degree in biochemistry or related biological discipline for two posts of Research Technician.

One post (BPL/RD/T5) will involve the production of monoclonal antibodies and their application to immunoassay and immunoaffinity purification procedures. An interest in protein purification and experience of cell culture/monoclonal antibody technology are desirable.

The other post (BPL/RD/T6) will involve the development of valid laboratory methods for the detection of pyrogens in a range of plasma protein products. The programme would entail devising procedures for the identification of pyrogenic components and their removal during processing. An interest in, or previous experience of, toxicology is desirable.

These are permanent positions. Remuneration will be commensurate with age, qualifications and experience. Salary range £4967 to £7896 pa (under review) inclusive of London Weighting. NHS superannuation scheme applies.

Please telephone the Personnel Office for application forms and a job description on Tel No. 01-953 6191, Ext 273, or write to Personnel Office, Blood Products Laboratory, Dagger Lane, Elstree, Herts WD6 3BX.

THE UNIVERSITY OF LEEDS

DEPARTMENT OF PURE AND APPLIED ZOOLOGY

POSTDOCTORAL RESEARCH FELLOW

Applications are invited for the above SERC-supported post to work with Professor R. McNeill Alexander on elastic mechanisms in the feet of mammals. The work will consist largely of dynamic tests, simulating running, on feet and tendons removed from carcases. The successful candidate may have obtained his or her doctorate either in a Biological Department, or in Physics or Engineering.

The post is available immediately for a fixed term of up to 21 months.

Salary within the IA Range for Research and Analogous Staff (£7520-£12 150) according to age, qualifications and experience.

Informal enquiries may be made to Professor Alexander (Tel 0532 431751, Ext 537).

Application forms and further particulars may be obtained from the Registrar, The University, Leeds LS2 9JT, quoting reference no 56/12. Closing date for applications 2 January, 1985.

AGRICULTURAL AND FOOD RESEARCH COUNCIL

FOOD RESEARCH INSTITUTE

RESEARCH CHEMICAL ENGINEER

(Higher Scientific Officer)

An Engineer is required to join a team studying the use of supercritical and liquid solvents for extracting ingredients from food and agricultural materials. The successful candidate will contribute to a background programme and provide an expertise that aids development of existing and novel technology.

Qualifications: A first or upper second class honours degree in an appropriate scientific or engineering discipline and at least two years' relevant postgraduate experience, preferably with a PhD. Applicants should have a strong commitment to the application of science and engineering to solve basic problems in food processing using mathematical modelling linked to experimental studies.

Salary: On the Higher Scientific Officer scale: £7435-£10 039. Non-contributory superannuation scheme.

The Agricultural and Food Research Council is an Equal Opportunities Employer.

Applications to the Secretary, Food Research Institute, Colney Lane, Norwich NR4 7UA, quoting ref. 83/6. Telephone enquiries to the Registry (0603 56122, Ext 230).

Closing date: 31 December, 1984.

THE SCIENCE CENTER BERLIN

International Institute for Environment and Society (ILES)

is presently looking for a

Research Fellow

for research in environmental policy

Qualifications:
Senior social scientist; theoretical and empirical experience in one of the following policy areas: agriculture, development, energy, law and environmental regulation, technology, bioengineering; thorough command of English; working knowledge of German would be an asset.

Contract conditions:
Three- to five-year contract; competitive salary and benefits package; commence 1 January 1985, or later.

Please send résumé within three weeks after publication of this advertisement to Science Center Berlin, International Institute for Environment and Society, Potsdamer Strasse 58, D-1000 Berlin 30, West Germany.

UNIVERSITY OF ABERDEEN
Department of Chemistry

RESEARCH IN SOLID ELECTROLYTES

Applications are invited for an SERC supported post doctoral research fellowship for studies on new Na^+ ion conducting solid electrolytes. The appointment is for two years and preference may be given to candidates with experience in solid state chemistry/crystallography/electrochemistry.

Salary in the range £7520 to £8450 with USS, depending on age and qualifications.

Applications or informal enquiries to Dr A. R. West, Department of Chemistry, University of Aberdeen, Meston Walk, Aberdeen AB9 2UE. Tel (0224) 40241, Ext 5648, as soon as possible.

Harrow College of Higher Education

Faculty of Science and Technology

Technician

Salary £6267-£6762 pa inc.

Required to service Physical Chemistry Teaching Laboratories to TEC Higher Certificate and Dip HE level.

Applicants should hold TEC Higher Certificate or equivalent qualification, and familiarity with spectroscopic and chromatographic techniques and a knowledge of basic electronics would be an advantage.

Application forms are obtainable and should be returned to, the Administration Office, Harrow College of Higher Education, Northwick Park, Harrow, Middlesex HA1 3TP. Tel: 01-864 5422 Ext 232. Closing date: 21 December, 1984.

Harrow is an Equal Opportunity Employer.

CRANFIELD INSTITUTE OF TECHNOLOGY

POST DOCTORAL RESEARCH ASSISTANT
Combustion Theory

The College of Aeronautics has a vacancy for a short period (eight months) of post-doctoral work on a SERC-sponsored research contract "Mathematical Modelling of Combustion and Explosion Phenomena". Opportunities for similar work on a longer time scale may arise during the short remaining period of the present contract.

Suitably qualified candidates should write, enclosing a cv to the Personnel Department (ref. 4044), Cranfield Institute of Technology, Cranfield, Bedford MK43 0AL.

FRIMLEY PARK HOSPITAL

LOCUM POST IN CLINICAL BIOCHEMISTRY

Basic grade Biochemist/MLSO

Applications are invited for the above post in the Biochemistry Department of Frimley Park Hospital, a District General Hospital of 562 beds with a complete range of services. The laboratory offers a routine analytical and consultative service to the Frimley Park Hospital Group. It participates in the training of Postgraduate students taking the MSc course in clinical Biochemistry at the University of Surrey.

SALARY: BG Biochemist £6559–£8311 pa.
MLSO £5738–£8096 pa plus Outer London Weighting £149 pa.

To view the laboratory please contact Mr D. Carlisle, Chief MLSO on Camberley 62121, Ext 4117.

Application forms available from the Personnel Department, Frimley Park Hospital, Portsmouth Road, Frimley, Camberley, Surrey. Telephone Camberley 62121, Ext 4007.

West Surrey and
North East Hampshire
Health Authority

Scientist/Engineer

Thermodynamic Simulation Studies

LONDON up to £10,520

The London Research Station of British Gas wishes to strengthen its Gas Properties and Measurement Group which is working on computer programs for thermodynamic properties and simulation of chemical processes. Current problems range from flow-sheeting of gas liquefaction processes, through the prediction of thermodynamic properties for substitute natural gas production, to modelling of two-phase flow in pipeline networks.

You will need a good degree in physics, chemistry or chemical engineering, together with up to 3 years' relevant experience. More experienced applicants will also be considered.

Starting salary will be within the range £7,899 – £10,520 [including Inner London Weighting]. Benefits are those normally associated with a large progressive organisation including assistance with relocation expenses where appropriate.

For further details and an application form, to be returned by 21st December 1984, please write to:
The Personnel Officer [Fulham], British Gas,
London Research Station, Michael Road, Fulham,
London SW6 2AD. Please quote ref LSR/246.

BRITISH GAS

DEPARTMENT OF ARTIFICIAL INTELLIGENCE

UNIVERSITY OF EDINBURGH

2 RESEARCH ASSOCIATES

Applications are invited for appointment to the post of Research Associate in the Department of Artificial Intelligence, to join a project working on 3D model invocation and 3D model matching. This is part of multi-site collaborative project, funded as an Alvey IKBS Image Interpretation Research Theme (Consortium II-3D Surface Representations and 3D Model Invocation from Stereo Cues).

One Research Associate will implement a model invocation and matching system, written in C. A second will extend an existing solid modelling system implemented in C, and provide interfaces to a robot programming system. For both posts a knowledge of UNIX and experience in C programming will be useful. A PhD in Mathematics, Physics, Computer Science, or equivalent industrial experience is required.

The posts will be funded for three years, and appointments can be made immediately. One post is on the RA(1A) scale (range £7520-£12 150) and the other on the RA(2) scale (range £11 205-£14 925). The rate depends on age and experience.

Applications (four copies) and the names of two referees should be sent to the Secretary's Office, Old College, South Bridge, Edinburgh EH8 4YL by 3 January 1985. Further details may also be obtained from the Secretary's office, up to 18 December, 1984.

Please quote reference no. 5220.

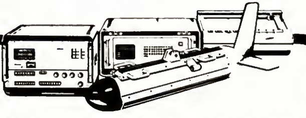
PIRA—PAPER AND BOARD DIVISION

We are the UK national technical centre for the paper and board industry, providing research, consultancies and technical services to our members and industrial sponsors.

We wish to appoint a high calibre graduate chemist with a minimum of three years research experience and two years industrial experience, to our Research Department, concerned with pulps and pulping processes and papermaking process chemistry. One current research project is directed to improving the utilisation of starches in paper and boardmaking.

This appointment will be as a Senior Research Officer and the initial salary will be in the range £10 000-£12 500 pa, exceptionally to £14 000.

Applications with cv, in confidence, are invited to: Mrs E. L. Fedrick, Paper and Board Division, Pira, Randalls Road, Leatherhead, Surrey.



WIMPOL Limited is an expanding company offering a wide range of professional services within marine geophysics, marine sciences and surface/underwater navigation. The company has offices in Swindon, Aberdeen, U.S.A., Egypt and China. To meet our expansion requirements, the company has vacancies in the following areas:

Marine Scientists (RFR 042)

Suitable applicants should have experience of oceanographic data collection and interpretation. A broad familiarity with computing and a background in marine civil engineering would be beneficial. Successful applicants will be involved in all aspects of marine survey and this will include both site work and the preparation of technical reports.

Oceanographic Engineers (KWS 039)

Candidates must be competent electronic engineers experienced in the maintenance and calibration of oceanographic equipment. Field experience in the operation of oceanographic systems would be desirable.
Successful candidates would be predominantly office based but periods of site work are anticipated.

All the posts offer excellent career prospects and the salaries (which are negotiable), benefits and allowances will be commensurable with those you would expect from a modern, expanding, major offshore survey company.

Applicants should send a full career resume to:
The Personnel Manager,
Wimpol Ltd., Hargreaves Road,
Groundwell Industrial Estate,
Swindon, Wiltshire, SN2 5AZ.

working for you offshore

WIMPOL

UNIVERSITY OF BRISTOL

DEPARTMENT OF VETERINARY MEDICINE

TWO TECHNICIANS

required (University Grade 5) for a three-year collaborative project funded by the Agricultural & Food Research Council, to investigate immune factors in cattle in relation to mastitis. One will be based at the Institute for Research on Animal Diseases, Compton, Nr Newbury, Berks, one will be based at the University of Bristol Veterinary School, Langford.

Previous laboratory experience essential, HNC or equivalent qualification required.

The work will involve the routine collection of samples and the use of a variety of immunological laboratory techniques.

Starting salary: £6581 pa.

Applications and curriculum vitae giving names of two referees should be sent to Professor F. J. Bourne, Department of Veterinary Medicine, Langford House, Langford, Bristol BS18 7DU by 17 December, 1984.

HAMPSTEAD HEALTH AUTHORITY
ROYAL FREE HOSPITAL
DEPARTMENTS OF THORACIC MEDICINE AND BIOCHEMISTRY

RESEARCH ASSISTANT

Salary £6979–£9353 p.a. inc

Research Assistant required to work in the Departments of Thoracic Medicine and Biochemistry on research projects studying the physicochemical properties of lung liquids. Experience in lipid chemistry is necessary. The post is available from January 1985 for a maximum of two years.

Job Description and Application Form available from the Personnel Department, Royal Free Hospital, Pond Street, Hampstead, London NW3. Telephone 01 794 0500 ext 4286 quoting post no: 7034.

Closing date for applications 21st December, 1984.

Development Chemist

May & Baker Ltd. is a leading manufacturer of pharmaceutical, fine chemical and agrochemical products and a part of Rhône-Poulenc, one of the world's foremost chemical companies.

We are currently looking for Development Chemists to join our Process Development Section at Dagenham, whose principal task is to develop and industrialise chemical processes, from the research stage through to a cost-effective, safe and reliable manufacturing operation. The work is both stimulating and demanding and success will depend on your ability to contribute effectively to a dedicated team.

You must have a good degree (at least an upper second) in Chemistry or Applied Chemistry, with particular emphasis on organic chemistry. We would be particularly interested to hear from applicants with post-graduate experience in a relevant field or practical knowledge of the fine chemicals industry from a manufacturing viewpoint.

We offer a competitive salary, together with a range of excellent benefits, including assistance with relocation where applicable. Career prospects within the group are excellent.

Please write with full details, quoting ref: NE/17, to:

M&B May & Baker

Martin Havelock,
Senior Personnel Officer,
May & Baker Ltd.,
Dagenham, Essex, RM10 7XS.
Tel: 01-592 3060, ext 2544.

POLYTECHNIC OF THE SOUTH BANK
Borough Road, London SE1 0AA

Department of Applied Biology

TECHNICIAN

Grade 4

Ref: TEC/34

Applicants must have a sound background in Laboratory Technology, specialising in microbiological techniques. They must be able to construct experimental prototype apparatus using hand tools. Candidates should be qualified to advanced City & Guilds certificate in laboratory work/HNC/HND with at least five years working experience. A knowledge of electronics would be an advantage.

Salary: £7358-£8276 pa inclusive.

Please telephone the Staffing Office for an application form on 01-928 8989 Ext 2355.

Closing date: 21 December, 1984.

The Polytechnic is an Equal Opportunities Employer.

NATIONAL INSTITUTE FOR BIOLOGICAL STANDARDS AND CONTROL

Immunology Section

TECHNICIAN

Applications are invited for the permanent position of Technician.

Applicants should possess a degree or equivalent in one of the Biological Sciences. Previous experience in immunohistochemistry and/or monoclonal antibody technology would be a considerable advantage. Salary scale is £5738-£8096 plus £1042 London Weighting pa. Starting point is dependent on age, qualifications and experience.

For further information and an application form contact the Personnel Office, NIBSC, Holly Hill, Hampstead, London NW3 6RB. Tel 01-435 2232. Please quote Ref. No. IM/134A.

CAMBERWELL HEALTH AUTHORITY

King's College Hospital

NUCLEAR MEDICINE TECHNICIAN
(Medical Physics III/IV Grade)

Salary Scale: III–£7450 to £9325 pa inc IV–£6446 to £8146 pa inc.

This post, which has a large service commitment to many different specialities, is based in the Nuclear Medicine Department at King's, one of London's major Teaching Hospitals. The postholder will be expected to provide an imaging service using Gamma Cameras and Computers, as well as an invivo service. Additionally, there will be a requirement to dispense radioisotopes and it may be necessary to attend other hospitals within the Authority.

Applicants should possess a relevant O Tech/H Tec qualification, science degree (or equivalent), and have gained three years appropriate experience. Other candidates may be considered for a Grade IV post according to qualifications and experience.

Informal enquiries to Dr J. Barrett, Director of Department of Nuclear Medicine, Tel 01-274 6222 Ext 2596.

Application forms and job descriptions available from Unit Personnel Department, King's College Hospital, Denmark Hill, London SE5. Tel 01-274 6222 Ext 2408. Ref. UP/693.

Closing date: 27 December, 1984.

TRANSLATORS

(Russian to English). Publisher of major Soviet scientific and technical research journals in English translation requires qualified translators in the following areas: electrical engineering, energy technology, aeronautics, machine sciences, superhard materials, friction and wear. Applicants must have a technical background in the field of translation. Ongoing assignments available. Application with cv to: Box D836, *New Scientist.*

VACANCY INT/003/84

AGRICULTURAL CHEMIST

The International Livestock Centre for Africa (ILCA) seeks an Agricultural Chemist/Laboratory Manager to be based at Headquarters in Addis Ababa. He or she will be responsible for the operation of a central laboratory in which determinations in the fields of soil, vegetation and nutritional chemistry are carried out. The laboratory is already well equipped and has a staff of approximately 20 including a qualified analyst and chief technician.

The successful applicant will have a degree in analytical agricultural chemistry or be an associate of the Royal Society of Chemistry or equivalent. He or she will have several years of experience in carrying out analyses in the fields mentioned above and will also have at least five years experience in laboratory management including ordering equipment, chemicals, supervision of staff, maintenance of laboratory standards, etc. While English is the main working language, knowledge of French would be an advantage.

Salary and related benefits will be in line with comparable International Organisations.

Applicants should airmail personal history and names of three referees. Applications citing the reference number should arrive not later than 31 January, 1985 to the Head of Personnel Department, International Livestock Centre for Africa, PO Box 5689, Addis Ababa, Ethiopia.

KOCH-LIGHT LIMITED

(A subsidiary of Genzyme (UK) Limited) is an internationally respected manufacturer of specialist and high security chemicals for research, industry and pharmaceutical intermediates. A vacancy has arisen for an ORGANIC CHEMIST with good practical ability to work on a variety of interesting projects within the research and development group.

Candidates would be required to have a BSc or equivalent in chemistry and research experience or a PhD in chemistry. Production experience is preferable but not vital.

Applications, with comprehensive cv should be sent by the 5 January, 1985, to Dr N. Dickinson, Koch-Light Limited, 37 Hollands Road, Haverhill, Suffolk C89 8PU.

ST MARY'S HOSPITAL MEDICAL SCHOOL
(University of London)
Norfolk Place, London W2 1PG

Department of Pharmacology

RESEARCH WORK IN DRUG METABOLISM

A postdoctoral or appropriately experienced graduate worker is required to join a research team working on aspects of the toxicology of flavour and fragrance chemicals. The successful applicant will be responsible for metabolic and pharmacokinetic studies in animals and human volunteers. Experience with in vivo studies would be an advantage. The post, which is available immediately, is for one year initially, renewable depending upon satisfactory progress. Salary according to experience on the Research Assistant 1A or 1B scales (1A £7520. AB £6600-£8920 + £1042 pa London Allowance).

Further details of the post are available from Dr J. Caldwell, Department of Pharmacology, (01-723 1252 Ext 142). Applications to Assistant Secretary (Personnel) at above address by 21 December, 1984.

CHARING CROSS AND WESTMINSTER MEDICAL SCHOOL
(University of London)

Department of Biochemistry

RESEARCH ASSISTANT

Applications are invited from Honours graduates, preferably with a First or Upper Second, in Biochemistry for the post of Research Assistant on a project funded by The Wellcome Trust. The project will investigate amino acid metabolism in liver and muscle. The appointment is for two years and it is anticipated that the successful candidate will register for a higher degree.

Commencing salary within range £6600-£7520 pa plus £1233 pa London Allowance. Further information can be obtained from Dr T. N. Palmer (Tel 01-748 2040, Ext 2602) and applications on forms obtainable from The Secretary, Charing Cross and Westminster Medical School, The Reynolds Building, St Dunstan's Road, London W6 8RP, to be submitted within three weeks of the appearance of this advertisement.

Analytical Chemists Move into Sales

c. £8,000-£12,000

We have a number of exciting and rewarding positions for Chemists in the sales field.

If you have a knowledge of Spectrophotometry, centrifugion, chromatography or industrial chemistry, and are ambitious with a commercial bias, then 'phone us immediately.

01-222 6334

Ross Warren Recruitment

PUBLIC HEALTH LABORATORY

St Luke's Hospital Guildford

MEDICAL LABORATORY SCIENTIFIC OFFICER

Applications are invited from science graduates with a degree in Microbiology which will be acceptable for State Registration by the Council for Professions Supplementary to Medicine.

Application forms and information from Mr J. P. Alexander, Head MLSO, at the above address, or Tel (0483) 66091.

INSTITUTE OF OCEANOGRAPHIC SCIENCES

Marine Physics Research

'Studies in the Upper Ocean'

The Institute has a three-year position supported by the Admiralty Research Establishment for research into the dynamics of the upper layers of the ocean, in particular those processes by which internal waves and shear in the thermocline are produced by atmospheric forcing and surface waves. The work will involve theoretical studies and observations at sea of near-surface motions, and may include laboratory experiments or the interpretation of data obtained by remote sensing if this becomes appropriate as the research develops.

Candidates should have a good Honours degree in Mathematics or Physics with some knowledge of fluid dynamics, and should preferably have some relevant research experience, for example in data collection and analysis or in numerical techniques applied to fluid motion.

The appointment will be made either at Higher Scientific Officer (£7149-£9561 pa) or Senior Scientific Officer (£8970-£11 476 pa) level according to qualifications and experience. A minimum of two years relevant post-graduate experience is needed for Higher Scientific Officer and four years for Senior Scientific Officer. Starting salary may be above the scale minimum.

The Natural Environment Research Council is not a Government Department, but conditions of service are similar to those in the Civil Service.

Please write or telephone for an application form and further details to:—
Institute of Oceanographic Sciences, Brook Road, Wormley, Godalming, Surrey GU8 5UB. Telephone Wormley (042879) 4141, ext 272.

Please quote Reference 84/012/1080.

The Closing date for the return of the applications is 20 December, 1984.

NATURAL ENVIRONMENT RESEARCH COUNCIL

IMPERIAL CANCER RESEARCH FUND

Software Engineer and Computer Technician

The Research Computer Unit provides computing facilities for data processing and theoretical work for the ICRF's scientists engaged in biological and clinical research. The main system, supporting over 100 terminals in several locations, is based on the DEC system 2060 and there are plans for its major enhancement. There are two vacancies.

1) **Software Engineer**
The Unit requires a software professional to supervise the system operation including the network software and to undertake the development and implementation of the system software tools for scientific applications.
Degree or equivalent. Salary range £8821 to £12 166.

2) **Computer Technician**
Responsibility for operation and further development of the software and hardware on several microcomputers used in the ICRF extramural clinical units for collection, storage, retrieval and simple analysis of medical information. The microcomputers are linked to the mainframe which is used for more complex data analyses; Interest in medical computing and information processing.
Degree or equivalent. Salary range £7038 to £9792.

For further information and application form telephone or write to Ms S. M. Hurley, Imperial Cancer Research Fund, Lincoln's Inn Fields, London, WC2 on 01 0200 Ext 305, quoting ref 27/85, and preference.

THE LONDON HOSPITAL (WHITECHAPEL)

Haematology Department

JUNIOR 'B'/MLSO

This famous London Teaching Hospital has a vacancy for a graduate in a suitable discipline or a person holding the H-Tec qualification in Medical Laboratory Science. There will be an opportunity to study for the professional examination of the Institute of Medical Laboratory Sciences after becoming State Registered. You will gain experience of the full range of duties carried out in a Haematology Department.

Salary £5926-£6077 (inclusive)

For an application form, please contact the Personnel Department, The London Hospital (Whitechapel), London E1 1BB. Telephone 01 247 5454 Ext 35.

Closing date for receipt of applications is 28 December, 1984.

HAMPSTEAD HEALTH AUTHORITY
ROYAL FREE HOSPITAL
ACADEMIC DEPARTMENT OF MEDICINE

BASIC GRADE BIOCHEMIST

Salary: £7601–£9767 p.a. inc

We are looking for a Biochemist who will be responsible for running the routine hepatitis B Virus DNA assay, and diagnostic radioimmunoassays for other hepatitis Viruses. In addition you will be a member of an active research group concerned with the treatment of patients with hepatitis with anti-viral drugs including interferon.

A good background in biochemistry or immunology as well as the ability to perform analyses to a high degree of accuracy is essential.

For Application Form and Job Description please contact the Personnel Department, Royal Free Hospital, Hampstead, London NW3 Telephone: 01 794 0500 ext 4286
Please quote reference no: 1063.

Product Development - Toiletries

Graduate – Oral Hygiene

The Toiletries R & D Department at Weybridge, Surrey provides technical support to a wide range of major international brands and is actively involved in new product development.

An opportunity has arisen for a Formulation Chemist to join a large team working on Macleans and Aquafresh toothpastes and other major development projects in the field of oral hygiene.

Applications are invited from graduate scientists, with a good honours degree in Chemistry or a related subject. The successful candidate will be able to demonstrate a high degree of motivation together with technical competence.

Benefits include a competitive salary, four weeks' annual holiday, non-contributory pension, free life assurance and flexible working hours.

Please send a full curriculum vitae to: Miss E. M. Holland, Personnel Manager, Beecham Products Research Department, St. George's Avenue, Weybridge, Surrey KT13 0DE.

Beecham Products B

MRC CLINICAL RESEARCH CENTRE
(NORTHWICK PARK HOSPITAL)
WATFORD ROAD, HARROW
MIDDX HA1 3UJ

SENIOR ANIMAL TECHNICIAN

A vacancy exists in the division of comparative medicine for a senior animal technician to assist in the care and management of a wide range of laboratory animal species. The person appointed will be responsible to the Chief Animal Technician for the supervision of up to 14 or more junior staff, and will be required to undertake routine animal husbandry duties.

Qualifications required are FIAT or HNC/Degree or equivalent in a biological subject, with extensive experience in laboratory animal technology. Salary will be within the range £8144-£10 558 (inclusive of London Weighting) depending on age and experience.

Application forms and further details obtainable from Miss B. A. Shaw, Personnel Section, quoting reference 102/2/3874.

Closing date 31 December, 1984.

IMPERIAL CANCER RESEARCH FUND

TECHNICIAN/RESEARCH OFFICER

required at our new laboratories at South Mimms, Hertfordshire to assist our Mutagenesis Laboratory with projects involving the molecular basis of mutation in mammalian somatic cells.

HNC or degree in biochemistry, molecular biology or genetics, or equivalent. Experience of cloning or DNA sequencing techniques would be useful. Salary range £6605 to £9359. Permanent appointment.

For further details and application form write or telephone Ms S. M. Hurley, Imperial Cancer Research Fund, Lincoln's Inn Fields, WC2 on 01-242 0200, Ext 305 quoting ref. 22/85.

Involvement + Variety = Rewarding Work

The Medical Physics Formula at the Leicester Royal Infirmary

Personally rewarding work and involvement in worthwhile projects, that's the promise of Medical Physics at the Leicester Royal Infirmary. We are part of Britain's newest medical school, we have a very modern and well equipped department and our Technicians are involved in a variety of work with the complete range of medical professions.

We currently have 3 posts at Technician III or IV level to join our Clinical Measurement section working on electro-diagnostics, anaesthetics and high-dependency technical service and general patient parameter measurements.

Applicants should be qualified to ONC/OTEC/HNC level in a relevant subject (preferably Medical Physics) and have technical experience of bio-medical technology. In service training will be provided for applicants with a non-medical background.

Salary scale is Technician III £6408 – £8283, Technician IV £5404 – £7104. New entrants to the NHS normally start at the minimum of the scale. Relocation assistance and temporary accommodation may be provided if necessary.

Further information may be obtained from Mr S Bentley, Tel (0533) 541414 ext 5486.

Application forms and job descriptions are available from the **Unit Personnel Department, Leicester Royal Infirmary, Infirmary Square, Leicester. Tel (0533) 546131 between 9.00 am and 5.00 pm.**

Leicestershire Health Service

UNIVERSITY OF LONDON
MSc IN ERGONOMICS

A one-year full-time or two-year part-time intercollegiate course for graduates with relevant honours degree (eg Engineering, Psychology, Physiology, Medicine, Architecture or Design). Account will be taken of practical experience. The course includes study of applied physiology and biomechanics, experimental and occupational psychology, systems and instrumentation. Case studies are presented and visits made to industrial and research organisations. An individual practical project is carried out.

Enquiries and applications (before 1 February, 1985) to: Dr J. B. Long, Ref. A02, Ergonomics Unit, University College London, 26 Bedford Way, London WC1H 0AP. Tel: 01-631 0889 or 01-636 2187.

University of Leicester
Department of Physics

Applications are invited for Research Studentships tenable from October 1985 and leading to the degree of PhD in the following areas:

Condensed Matter Physics
Ionospheric Physics
Nuclear Electronics
Quantum Molecular Physics
Radiation Physics
Theoretical Physics
X-Ray Astronomy

The Studentships provide an opportunity to join an active department engaged in research in topics of fundamental and technological interest. They will be suitable for graduates in Physics, Chemistry, Mathematics and Engineering.

Applications, which should include the names of two referees, should be sent to Dr C. Norris, Department of Physics, University of Leicester, Leicester LE1 8RH.

UNIVERSITY OF LEICESTER
Department of Medicine

The University Department which is based at the Clinical Sciences Building at Leicester Royal Infirmary, requires a

GRADE 3 TECHNICIAN

to assist with research into AII receptors in the kidney in hypertension by autoradiography. (This appointment is being made on a two year grant funded by the National Kidney Research Fund) and is effective from 1 January, 1985.

Previous laboratory experience in a biological or medical sciences department is essential and applicants should be qualified to ONC standard or equivalent. Salary scale £5399-£6325 a year depending upon qualifications and experience.

Applications (including a cv) should be made in writing and sent to Mrs J. M. Brice, Chief Technician, Department of Medicine, Clinical Sciences Building, Leicester Royal Infirmary, Box 65, Leicester LE2 7LX, as soon as possible.

BIRBECK COLLEGE
(University of London)

Laboratory of Molecular Biology, Department of Crystallography

RESEARCH OFFICER

Applications are invited for a Postdoctoral Research Officer with experience in crystallography, to work on a project funded by the SERC on the three-dimensional structure of polypeptide hormones. The post is of 23 months' duration, commencing as soon as possible. Please apply to Professor T. L. Blundell, FRS, Laboratory of Molecular Biology, Department of Crystallography, Birbeck College, Malet Street, London WC1E 7HX (telephone 01-580 6622, Ext 284) enclosing a cv (in duplicate) and the names of two referees. Please quote ref CRO/NS.

National Heart and Chest Hospitals

THE LONDON CHEST HOSPITAL
Bonner Road, E2 9JX
Tel 01-980 4433

JUNIOR B MLSO
Department of Microbiology

required for this small but busy postgraduate teaching hospital undertaking Cardiothoracic Medicine and Surgery. Previous experience desirable but not essential. Applicants should possess two Science A Levels, one of which should be Chemistry, have a science degree or have passed the OTec.

The post will be based initially at the London Chest Hospital, but will be required to rotate to the laboratory at Brompton Hospital, London SW3.

Application form and job description from Miss T. Long, Ext 419. Further details from Mrs M. D. Chadwick, Department of Microbiology, Brompton Hospital, Tel 352 8121, Ext 4517.

ST THOMAS'S HOSPITAL MEDICAL SCHOOL

United Medical and Dental Schools of Guy's and St Thomas's Hospitals

RESEARCH TECHNICIAN

(MLSO point 02) required for 18 months to assist with neurophysiological research on movement control in animals. Experience with electronics, computing or histology desirable.

Written applications, including curriculum vitae and names of two referees, to Professor A. Taylor, Sherrington School of Physiology, St Thomas's Hospital Medical School, London SE1 7EH, by 20 December, 1984.

FOR SALE

ELEGANT AND VIVACIOUS

Ideal presents for Naturalists, Biologists or Collectors of Fine Prints and Drawings. Jonathan Kingden's animal drawings. Signed prints £19. Facsimile prints £22. Folio or bound in book form.

Write to Pangolin Prints, Islip OX5 2SD for details.

LASER WORKSHOP COURSES

Department of Physics, University of Essex

ONE-WEEK RESIDENTIAL COURSES ON LASER APPLICATIONS

SIXTH SERIES, SPRING 1985

Each course is designed to provide participants with an authoritative survey of the techniques, problems and possibilities in a broad area of laser applications, given by speakers from industrial, government and university laboratories.

LASER CUTTING, WELDING AND MATERIALS PROCESSING

(21st-25th January)

LASERS IN MEDICINE

(4th-8th February)

LASERS IN THE PRINTING INDUSTRY

(18th-22nd February)

OPTICAL METHODS IN ENGINEERING METROLOGY

(4th-8th March)

ADVANCES IN OPTICAL COMMUNICATIONS

(18th-22nd March)

For details please write to the Secretary (NS), Laser Workshop Courses, University of Essex, Wivenhoe Park, Colchester CO4 3SQ, or phone Colchester (0206) 862286 extension 2143.

Cranfield

5 day course for R&D staff

ENGINEERING EXPERIMENTATION

28 January – 1 February, 1985

An intensive residential course for scientists and engineers in industry whose responsibility is for product development.

The course reviews and explains both the standard techniques of experimental science and the new techniques and equipment that have become available.

The course includes practical work and demonstrations as well as lectures.

Details: The Short Course Officer (Ref 1076)
Cranfield Institute of Technology,
Cranfield, Bedford, MK43 0AL.
Tel: (0234) 750111 Ext. 3564.

UNIVERSITY OF STRATHCLYDE

MSc in Pharmaceutical Analysis

Applications for the one-year instructional course starting in October 1985 are invited from Honours graduates in Pharmacy, Chemistry or Biochemistry and from those graduating in 1985. The course is specifically orientated to the requirements of the pharmaceutical industry and hospital service, and offers options in:

(a) Quality Control of Pharmaceuticals or
(b) Biomedical Analysis

Studentships are available.

For further information, write to Dr A. G. Davidson, Course Supervisor, Dept. of Pharmacy, University of Strathclyde, Glasgow G1 1XW or telephone 041-552 4400, Ext 2512.

BIRKBECK COLLEGE (University of London)

STRUCTURE, EVOLUTION AND ACTION OF PROTEINS

A discussion of modern views concerning the evolution and molecular mechanisms of action of enzymes, allosteric proteins, polypeptide hormones, receptors, protein of chromatin and antibodies. The course will be held on Tuesday and Thursday evenings from 6pm-9pm in the 11 weeks beginning 8 January 1985. It is suitable for graduates in Chemistry, the Biological Sciences, or those with equivalent technical experience. Instruction will be by lectures and practical demonstration, using a large selection of protein models and modern experimental techniques. Satisfactory completion of the course will be noted by the award of a certificate. For further information, please apply to: Professor T. L. Blundell, FRS, Laboratory of Molecular Biology, Department of Crystallography, Birkbeck College, Malet Street, London WC1E 7HX. Tel: 01-580 6622, ext 284.

STUDENTSHIPS

UNIVERSITY COLLEGE LONDON

POSTGRADUATE STUDENTSHIP

Applications are invited from graduates with a first or upper second class honours degree in Botany, Biology or a related subject, for an SERC Research Studentship to commence as soon as possible. The project concerns plant responses to water stress as a mechanism isolating interfertile species.

Further details and application forms from Dr K. Taylor, Department of Botany and Microbiology, University College London, Gower Street, London WC1E 6BT. Tel 01-387 7050, Ext 342.

UNIVERSITY COLLEGE LONDON

SERC-CASE AWARD (GLAXO)

PhD Studentship available for project involving use of currently available human T cell receptor α and β chain probes in a study of the regulation of T cell receptor gene expression in T cell related diseases under supervision of Drs A. Williamson, M. Owen and M. Feldmann.

Existing or expected First class or III honours degree essential, preferably in Biochemistry/Molecular Biology.

For further information, please contact Dr M. Feldmann, Department of Zoology, University College London, Gower Street, London WC1E 6BT.

BIRKBECK COLLEGE
University of London

SERC CASE STUDENTSHIP IN THE OPTIMAL DESIGN OF CHROMATOGRAPHY COLUMN PACKINGS

This project will investigate the relationship between chromatographic column particle size distribution and compressibility, and the efficacy of the columns in separation of cells or proteins, and will thus design optimal distributions for future chromatographic use. The research involves the application of computational techniques to the construction and analysis of mono and polydisperse packings, for which training in computing and computer graphics will be given.

The studentship will be held jointly with Pharmacia Limited, a world leader in the field of chromatographic techniques. Applications from graduates with a First or Upper Second Class Honours degree in Physics, Mathematics, Chemistry, Computing , or related subjects should be made to: Dr J. L. Finney, Department of Crystallography, Birkbeck College, Malet Street, London WC1E 7HX. Tel 01-580 6622, Ext 420 or 284, enclosing a curriculum vitae and the names of two academic referees.

Cranfield Institute of Technology
College of Aeronautics

RESEARCH STUDENTSHIPS

Gas Dynamics and Combustion

Two Research Studentships are available to enable suitably qualified graduates to carry out research in the general area of gas dynamics and combustion. The work will be largely theoretical in character and will especially suit either applied mathematicians with a fluid mechanics specialisation or other graduates with a good knowledge of fluid mechanics and mathematical methods.

Successful candidates will register for the degree of PhD, or possibly MSc by research; they must be UK citizens with a first or upper-second class honours degree. Opportunities may arise for employment as a Research Assistant.

Write enclosing a cv to Professor J. F. Clarke, College of Aeronautics, Cranfield Institute of Technology, Bedford MK43 0AL.

Southampton
THE UNIVERSITY

Department of Mechanical Engineering

SERC CASE STUDENTSHIPS

Applications are invited from graduates in Engineering, Metallurgy or Chemical Engineering for two SERC CASE Studentships, leading to the degree of PhD, in the following fields:

1. Development of Welding Consumables for High Temperature Operations

In collaboration with CEGB, studies in the development of welding consumables for stainless steel components used in the power generation industry.

2. Bubble Size Measurements in Foam

In collaboration with the Fire Research Station, studies in investigating methods of continuous measurement of bubble sizes in liquid/gas foams.

Applications are also invited for a **Research Fellowship** which is anticipated for January 1985, in the field of Foam Rheology. Salary in the range £7520-£8450 dependent upon age and experience.

Applications, indicating post sought, should be addressed to Mr J. Hyde, Department of Mechanical Engineering, University of Southampton, Highfield SO9 5NH.

SERVICES

FOR ALL TECHNICAL TRANSLATIONS FROM JAPANESE contact Ingatestone Translations, 57 High Street, Ingatestone, Essex CM4 0AT. Tel (0277) 353863 and 354022.

FELLOWSHIPS, GRANTS & SCHOLARSHIPS

NATIONAL FUND FOR RESEARCH INTO CRIPPLING DISEASES

Vincent House, North Parade, Horsham

RESEARCH TRAINING FELLOWSHIPS

APPLICATIONS INVITED

The National Fund for Research into Crippling Diseases (Action Research for the Crippled Child) is a charity concerned with promoting research into all aspects of crippling regardless of cause, condition or age group. Applications are invited for a limited number of Research Training Fellowships in the UK specifically to further the training of young medical and non-medical graduates (and others with appropriate professional qualifications and experience) in research techniques and methodology.

The fellowships will generally not exceed two years and are NOT awarded as project grants or for the purpose of higher/postgraduate education. Starting salary will in no case exceed that of a third year Senior Registrar or equivalent. Up to £1000 pa for appropriate research expenses may be allowed to the department where the training will be undertaken.

Application forms, which are available on written request to the Assistant Director (Research), should be returned by 31 January, 1985.

Vacant Research Appointments

The Council of the Royal Society invites applications for appointments tenable from 1 October 1985;

1. An EPA Cephalosporin Fund Research Fellowship for research in chemical science applied to medicine.
2. A Foulerton Gift and Binmore Kenner Research Fellowship for research in chemical science applied to medicine.
3. A Stothert Research Fellowship for research in medicine, including the science upon which medical knowledge is based.
4. A Florey Fellowship tenable in Australia for research in the biomedical sciences.

Appointments are subject to the Society's General Regulations governing Royal Society Research Appointments (1-3) and the conditions of award governing the Florey Fellowships (4).

All candidates must have a PhD or equivalent research experience. There are no restrictions on nationality of applicants or proposed places of tenure for 1 or 3. Candidates for 2 must be British nationals whose fathers and paternal grandfathers are or were of British nationality. Candidates for 4 must be normally resident in the United Kingdom and intending, if appointed, to return to the United Kingdom after two years in Australia.

Salaries and conditions of tenure:

1. Salary scale £11 327 × £488 to £13 767 per annum. Tenure for three years in the first instance, possible renewal for two years.

2,3. Salary scale £8141 × £467 to £10 476 per annum. Tenure for three years in first instance, possible renewal for two years (2) and two years in first instance, possible renewal for further one or two years (3).

4. Stipend Australian $25 956 per annum (£15 880) for candidates under 28 years and $28 181 (£17 240) for those 28 years or over.

For all appointments superannuation benefits will be provided: in addition for (4) family allowances and return air fares for the Fellow and family. There will be some provision for research expenses (1-3) and the point of entry on the relevant salary scale will be determined by Council.

Preferred age limits:
On 1 October 1985: 1. Under 33 2, 3. Under 26
On 11 February 1985: 4. Younger than 30

Method of application:
Apply (by letter) for application form and further details (*stating for which appointment*).

Address: The Executive Secretary (UMAM), The Royal Society, 6 Carlton House Terrace, London SW1Y 5AG.

Closing date: 11 February 1985.

THE ROYAL SOCIETY

Royal Society 1983 University Research Fellowships

The Council of the Royal Society invites applications for 14 appointments to be supported from the Society's Parliamentary Grant-in-aid and tenable from 1 October 1985 as Royal Society 1983 University Research Fellowships.

All applicants must have a PhD or equivalent research experience; they must be at least 26 but should not have passed their 33rd birthdays by 1 October 1985. In an exceptional case, however, an award may be made to an applicant who has passed his/her 33rd birthday by this date but who has outstanding ability for independent scientific research and who is able to demonstrate that there are special reasons why he/she should still be eligible for a fixed-term research fellowship. Applicants must be British Citizens (of the United Kingdom) and must hold the appointments in departments of science (including agriculture, medicine, mathematics, engineering and technology) in universities in the United Kingdom. Persons already holding substantive posts in universities in the United Kingdom will not normally be considered.

Appointments, which will be subject to the Society's General Regulations governing Royal Society Research Appointments, will be for up to five years with the possibility of renewal for two successive periods of up to three and two years. Salary will be on the University Lecturers' scale for non-clinical academic and related staff with entry point related to age and London Allowance where appropriate. A basic grant of £900 per annum will be provided for research expenses.

The primary criterion for selection will be the scientific merit of the individual applicant based on his or her record so far and on future potential. Account will be taken of the facilities and intellectual environment being offered by the prospective host department. Preference will be given to applicants who wish to hold their appointments in departments which at present have few or no young (i.e. under 35) staff. Each application will need to be accompanied by a statement from the head of the prospective host department who will be asked to confirm that the applicant could be expected to be a very strong candidate for a permanent post at the end of the Fellowship period.

Applicants who were unsuccessful in 1983 or 1984 should not be deterred from applying in 1985 if they are eligible to do so. They should, however, make a fresh application on a new application form and arrange for updated statements from referees and the prospective head of department to be provided.

Apply (by letter) for forms for completion by applicant and head of department and further details.

Address: The Executive Secretary (UMAM),
The Royal Society, 6 Carlton House
Terrace, London SW1Y 5AG.

Closing date: 11 February 1985.

IMPERIAL CANCER RESEARCH FUND

BURSARIES FOR TRAINING IN RESEARCH

A number of Bursaries will be awarded in 1985 in the Fund's laboratories at Lincoln's Inn Fields, St Bartholomew's Hospital, University College London, South Mimms, Herts, Mill Hill NW7, and Edinburgh for full-time studies leading to higher degrees in research fields relevant to cancer.

The awards will be tenable for three years from 1 October, 1985 with a grant of £4865 (subject to tax) and, in some cases, additional allowances.

Applications are invited from candidates, no more than 25 years of age on 1 October, 1985, who have been resident in the UK since October 1982 (although non-residents are not excluded from consideration), and who hope to obtain a First or Upper Second Class Honours Degree.

Further details and application forms are available from:

The Personnel Officer,
Imperial Cancer Research Fund,
Lincoln's Inn Fields,
London WC2A 3PX
(tel: 01-242 0200 ext: 305)

Completed application forms should be returned as soon as possible.

NATIONAL FUND FOR RESEARCH INTO CRIPPLING DISEASES

Research Training Fellowship in Biomedical Engineering

The National Fund for Research into Crippling Diseases supports medical research leading to the prevention of disability and the alleviation of existing physical handicap. Applications are invited from suitably qualified medical practitioners or experienced bioengineers for a one year Research Training Fellowship in bioengineering.

Starting salary will be according to seniority (maximum senior registrar grade or equivalent) and up to £1000 for appropriate research expenses may be granted to the department where the training will be undertaken.

Application forms, which are available on written request to the Assistant Director (Research), National Fund for Research into Crippling Diseases, Vincent House, North Parade, Horsham, West Sussex, should be returned by 31 January, 1985.

UNIVERSITY OF EDINBURGH

Research Fellowships

are available in the following subject areas:—

Adaptive Filter Design
Fiber Optic Instrumentation Systems
VLSI Design for Signal Processing
VLSI Process Simulation

for people possessing PhD Degree or BSc plus relevant industrial experience.

Further particulars are available from and application with CV and names of two referees should be submitted to Professor J. Mavor, Department of Electrical Engineering, University of Edinburgh, Kings Buildings, Edinburgh EH9 3JL. Tel: 031-667 1081, Ext 3591.

Please quote reference No 5221.

LINCOLN COLLEGE, OXFORD

THOMAS ROTHERAM JUNIOR RESEARCH FELLOWSHIP IN MATHEMATICS

The College invites applications from graduates, of either sex, under 28 years of age on 1 October, 1985, for the Thomas Rotheram Junior Research Fellowship in Mathematics, tenable for three years from October 1985; applications from older candidates will be entertained in special circumstances only. The present salary is £7060, rising to £7980, plus allowances. Further particulars and application forms may be obtained from the Rector, Lincoln College, Oxford OX1 3DR, to whom applications should be submitted by 12 January, 1985.

NEWNHAM COLLEGE

Applications are invited from women graduates of any university for one stipendiary Research Fellowship in the Sciences, tenable for three years from 1 October, 1985. Application forms and full particulars may be obtained from the Principal, Newnham College, Cambridge CB3 9DF. The closing date for the receipt of applications is 1 February, 1985, and selected candidates will be invited in mid-February to submit two copies of a dissertation, or other written work, by 1 March, 1985. The College expects to reach a decision in April 1985.

APPOINTMENTS WANTED

TECHNICAL/ LABORATORY MANAGEMENT

BSc (Hons) Chemistry (35) with extensive managerial experience as departmental head of one of the largest industrial laboratories in Republic of South Africa. Will relocate to any area in UK. Tel (0722 74) 2436.

GRADUATE

BSc Zoology (Hons), 23, very keen birder (exp in census work), botanist, very hardy, seeks employment in field of nature conservation/ wardening etc. Box D840.

AWARDS

Cranfield

School of Mechanical Engineering

M.Sc. RESEARCH AWARD

A bursary to the value of £3000 pa is offered for up to two years to a good honours graduate in engineering or science wishing to study for an M.Sc. by research in the field of Thermal Power.

The award offers a rare opportunity to study for a higher degree whilst actively participating in one of a wide range of research projects sponsored by Government and industry. Topics of current interest relate, for example, to the design and performance of devices for efficient fuel atomisation and vaporisation in gas turbine engines and studies of the fluid mechanics of compact, vortex-controlled diffusers.

For further details and an application form please contact Professor J. B. Moss (Ref.1078), School of Mechanical Engineering, Cranfield Institute of Technology, Bedford MK43 0AL, or telephone Bedford (0234) 750111, Ext. 2364.

Pharmacy Department
at Queen's University
of Belfast
and
Beecham Products Research Department

CASE AWARD

Design of Controlled Drug Delivery Systems

Applications are invited for a studentship funded by the SERC under its CASE AWARD scheme.

The research project will give the successful applicant an ideal opportunity to work in this active field. While the research will concentrate on the fundamentals of the design of novel drug delivery systems, a major objective will be the development of marketable innovations.

Applications in the form of a detailed curriculum vitae should be sent to each address with the names of two referees.

Professor P. F. D'Arcy,
Queens University of Belfast,
University Road,
Belfast,
BT7 1NN.

Miss E. Holland,
Personnel Manager,
Beecham Products Research Dept.,
St. George's Avenue,
Weybridge,
Surrey.

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ARIADNE

OH, THE CALM of it all, the cooling relief of the voice of science. The very title of the booklet produces the authentic relaxation of a cold hand on the brow. Published by the British Museum (Natural History), it reads *Insects of the Falkland Islands*. Its introduction, slowing the pulse with every word, starts: "The Falkland Islands are a compact group of more than 200 islands with a land area of 6270 square miles. Their position in the South Atlantic ... is at the same latitude as the northern tip of Tierra del Feugo ...." It goes on, like balm: "They are treeless, with extensive areas of moorland subject to low-density grazing by sheep." None of that dramatic grazing by cattle hereabouts and in the Falklands even sheep-grazing, normally a shade on the exciting side, is low-density. What could be more soothing? "Lowlands areas may be sandy; some low-lying islands from which sheep are absent, may support almost pure areas of tussac ..."

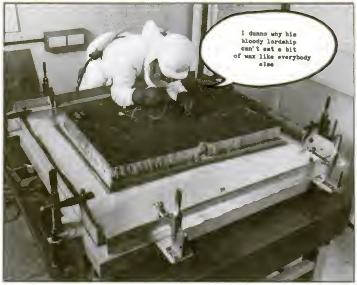
As in a dream, it continues: "While famous for their vertebrate wildlife, the Falklands have received very little attention from entomologists. Difficulty of access, coupled with harsh field conditions and an insular fauna of restricted size, have minimised the islands' appeal. The recent war in the Falklands (Eddy, Linklater and Gillman, 1982) has resulted in widespread interest in the islands and their biota."

Yes, well, it did have that result, as, no doubt, Eddy, Linklater and Gillman noted. Me, I'm drifting off on my bank of almost pure tussac ... □

EVERY now and then the subject of one-size, or fit-all, tights for women comes up. They don't of course, and there are sad pictures of droop, wrinkles like Atlantic rollers and rolled-up waists of life-jacket proportions. The march of standardisation, I see, has reached men's socks.

I see this from the calves of a friend. He is trying to cope with the fit-all-feet socks that, because they do nothing of the sort, have to have elastic knitted into the tops. That drives him crazy with itching and blocked circulation, so he cuts the elastic all round with scissors, making vertical incisions. It relieves him but it makes the tops of his socks look bedraggled, like melting, collapsing tops of castle keeps, limp socks designed apparently by Dali. □

IT IS easier to think of a private heaven than a private hell. Bach played by Bach, conversations with Einstein or Dostoevsky while being waited on by Marilyn Monroe serving marzipan—these visions are conjured up agreeably enough, but hell is hard and platitudinous, coming under some general heading such as torment.


I dunno why his bloody lordship can't eat a bit of wax like everybody else

I have a suspicion that one form of hell for me would be an endless journey on the London Underground with nothing to read, not even advertisements. They are a lifesaver, like the back of someone else's newspaper, but they have, I discover, lost one of their attractions. It may be because there are enough computer programmers in the world, or because there was something bogus about the particular schemes. But the invitations to join a course for computer programming seem to have vanished.

What was interesting was not so much the advertisements but people's reactions to them. They took the form of four or five puzzles, the kind that are used in so-called intelligence tests. You could watch someone attempting to solve them. Those succeeding would glance round at the other passengers complacently, a slight smile signalling achievement. Failing on one, some would give a snort of impatience. Others would keep sneaking furtive looks over the top of a page. There could be a row of travellers all moving their lips silently while staring at the ceiling. I once heard a young woman wailing as she squeezed out between the closing doors. "But why is it 23?"

I suppose that for some people, hell might be a perpetual journey with nothing to read but computer-programming puzzles. □

THERE are some retorts that are so perfectly apt and so well expressed that they stay in the mind for ever. One famous example is that of John Wilkes when told by an aristocrat that he would either die of the pox or be hanged. Wilkes replied: "That depends, my lord, on whether I embrace your mistress or your principles."

I suppose that T. H. Huxley's reply in 1869 to an invitation to join the Dialectical Society, an organisation concerned with Spiritualism and the forerunner of the Society for Psychical Research, may be just as famous, but I had not run across it until the other day. It is not as epigrammatical as Wilkes's, but it is just as demolishing. In part, it runs, "But supposing the phenomena to be genuine, they do not interest me. If anybody would endow me with the faculty of listening to the chatter of old women and curates in the nearest cathedral town, I would decline the privilege, having better things to do. And if the folk in the Spiritual world do not talk more wisely and sensibly than their friends report them to do, I put them in the same category. The only good that I can see in a demonstration of the truth of 'Spiritualism' is to furnish an additional argument against suicide. Better live a crossing sweeper than die and be made to talk twaddle by a 'medium' hired at a guinea a séance." □

LAST week, Daedalus outlined his "photoconductive magnetic pump", which entrains and compresses the Earth's magnetic field by means of laser-induced high-speed conducting zones swept continuously inwards through the walls of a photoconductive container. His idea was to create magnetic fields high enough to decompose all chemical substances by unpairing their bonding electrons.

Daedalus is now considering what happens at slightly lower fields: ones sufficient to weaken chemical bonds almost totally, but not quite to break them.

Since chemical change is "driven" by the energy released when atoms released form strong bonds, Daldalus reasons that such fields must drastically slow or even arrest all chemical reactions.

The most dramatic application of this powerful principle is suspended animation. Anyone placed in Daedalus's "magnetic suspender" will instantly lapse into total biochemical arrest. All vital functions will be suspended, but no damage will be done; on removal the person will return immediately to life, with no memory of the event or awareness of any gap.

The immediate benefactors will be working mothers. Merely by placing her baby in the magnetic suspender every morning, a mother will "switch it off" in mid-scream, leaving it safe and stable all day till she returns from work.

Similarly, if she wants to go out in the evening, or take a fortnight's holiday, she will be as free to do so as her husband. The baby will notice nothing. Indeed, it will be happier than ever; as far as it is concerned, it will be surrounded by doting parents all the time.

If a child spends half its time in magnetic suspension, it will probably take 30 years or so to reach adolescence; a useful advantage. For its parents would be saved from the mid-life "empty-nest syndrome", and would be happily occupied with family and career until they retired.

Many other liberations may also be possible. Those who hate the British winter could hibernate magnetically, and live a life of 140 consecutive summers. And, of course, the problem of unemployment would have a new and revolutionary solution. □

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IN THIS ALIEN ENVIRONMENT, SPACE TECHNOLOGY IS OUT OF ITS DEPTH

Inspecting underground gas pipelines for faults may not sound like the ultimate high-tech challenge. But, in fact, the task proved to be beyond the 'state-of-the-art' technologies previously available – even in military and aerospace applications.

PROBLEM:

Design a vehicle which can travel inside the pipe, carrying equipment capable of identifying any significant defect, and pinpointing its position to within a metre in a run of up to a hundred kilometres or more.

SOLUTION: THE INTELLIGENT PIG

The Intelligent Pig, developed by the gas people, is a vehicle carrying highly advanced sensing, data processing and recording equipment. Driven through the pipe by the gas pressure within it, the Pig can be used without taking the pipe out of service.

What is more, it can not only pinpoint any defect on the inside or outside of a steel pipe, but even describe its nature.

HOW?

Using strong magnetic fields or elastic waves propagated at ultrasonic frequencies, different types of sensors can detect corrosion, cracks, impact damage or distortion of the pipe. But the real challenge lay in processing the hundreds of millions of signals produced by the sensors in an average run.

THERE WASN'T A COMPUTER SMALL ENOUGH AND TOUGH ENOUGH

Many of the pipes to be inspected are less than 305mm in diameter. To fit sufficiently powerful data processing equipment into the tiny space available, hybrid microcircuits incorporating custom-designed silicon chips had to be developed. And since the space restrictions also limit battery size and therefore power, many of these highly advanced electronic components have to operate at the very limits of their specifications. What's more, the environment inside the pipe isn't exactly friendly. All the highly sophisticated equipment carried by the Pig has had to be designed to tolerate or be protected from extreme vibration, mechanical shock, dirt, and gas pressure of up to 70 atmospheres.

A 'TOMORROW'S WORLD' TAPE RECORDER

The sheer volume of data to be stored inspired the development of what is probably the most advanced ultra-miniaturised tape recorder currently in existence. Making extensive use of subminiature hybrid microelectronics, new types of recording heads and ultra-precision mechanical engineering, this little marvel can store up to 500 million readings on a single reel of standard one-inch tape, with an accuracy of better than one-thousandth of one percent!

FROM REEL TO REELS

Once the Pig has finished its run, the next job is to prepare the data for analysis by powerful, advanced computers such as the VAX 11/780. There's so much information in the Pig's tiny recorder that many reels of computer tape are needed to receive it, and many hours of computer time to analyse it.

THE RESULT

Britain's underground gas transmission network is a multi-billion pound asset. And the technical pyrotechnics we've just described have a thoroughly down-to-earth end result – they help the gas people to maintain this asset more efficiently and cost effectively.

WHY THE GAS PEOPLE LIVE IN THE FUTURE

The fact that gas is Britain's most popular domestic fuel – and a powerful and growing force in industry, too – is the result of many years' foresight, planning and massive investment by British Gas scientists and engineers. And they're still working for the future – to meet Britain's energy needs in the next century.

THE GAS PEOPLE – WORKING FOR TOMORROW'S WORLD TODAY

Gas

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